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# The Dock & Harbour Authority

No. 434. Vol. XXXVII. DECEMBER, 1956 Monthly 2s. 6d.



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# New Ipswich Dredger works between Berthed Ships

## Efficiency of Priestman Grab-Hopper Proved

The Ipswich Dock Commission have recently taken delivery of the 370-tons capacity Diesel-driven Grab Hopper "Samuel Armstrong."

This vessel was built by Henry Robb Ltd., Leith, in accordance with the requirements of Lloyds Register of Shipping and the Ministry of Transport and Priestman Brothers Limited were the Consultants.

The principal dimensions are:

| | | | |
|---|---|---|---|
| Length between perpendiculars ... | ...128′ 6″ | Hopper capacity, tons ... | 370 |
| Breadth moulded ... | 28′ 6″ | Oil fuel capacity, tons ... | 20 |
| Breadth overall ... | 30′ 3″ | Engine b.h.p. ... ... | 700 |
| Depth moulded ... | 12′ 0″ | Engine r.p.m. ... ... | 350 |
| Loaded draft, mean ... | 10′ 6″ | Speed on trials, knots ... | 10.5 |

This vessel is of the single-deck type and the hull is sub-divided by watertight bulkheads.

Approximately amidships is located the steel all-welded hopper with its ten steel, wood-lined, doors hinged on the hopper sides. The doors are raised in pairs by means of an electric winch with extended warping ends and are held in the raised position by means of large steel cotters which are knocked out to lower the doors.

*An additional feature which is fitted to the Priestman crane is a special lifting attachment for salvage work whereby the crane is able to lift loads up to 20 tons over the stem.*

The dredging crane, which is diesel driven, is of the Priestman No. 50 size and operates either a 70 cu. ft. Mud or a 55/44 cu. ft. Heavyplate Grab in sand or similar materials. On trials, 410 tons of spoil were loaded into the hopper in 78 minutes, the crane making 118 operations in this time in a depth of water of 30-ft.

The dredger is propelled by a Crossley 8-cylinder two-stroke marine oil engine running at 350 r.p.m. and on trials a loaded speed of 10.5 knots was attained.

All the accommodation is aft on the main and boat decks and consists of two single-berth cabins for the Master and Chief Engineer and three two-berth cabins for the crew. The total working crew consists of five men.

The vessel in service does one round trip per day and has to travel 14 miles to the open sea off Harwich to dump the spoil.

All the deck machinery is electrically operated at 110 volts D.C., the power being supplied by two Dorman-engined auxiliary generators situated in the engine room, one of these sets being a stand-by.

The vessel is named after the present Chairman of the Dock Commission and the photograph shows her working at Cliff Quay, Ipswich.

Prior to the purchase of this new dredger the dredging in the dock and along the quays was done by an old steam dredger which was unable to cope with the work with the result that contracts had to be made from time to time. The Samuel Armstrong will be able to do all this work and, by virtue of her handiness, she will be able to dredge in confined spaces between ships laid at the berths.

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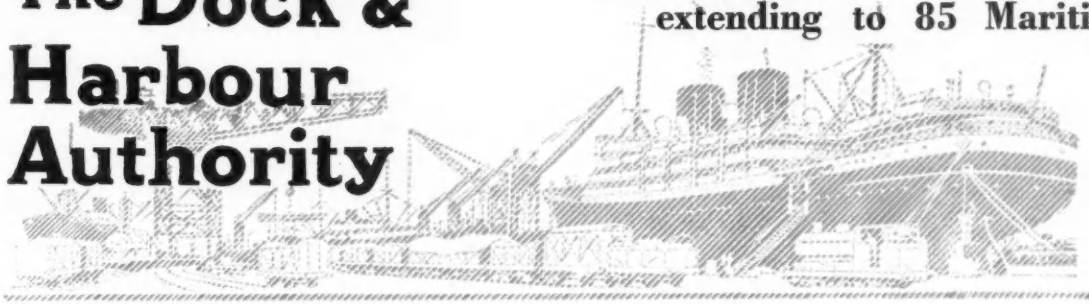

No. 434

Vol. XXXVII.

DECEMBER, 1956

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# Editorial Comments

**New Dry Dock at South Shields.**

On the 14th September last, the Civil Lord of the Admiralty, Mr. Wingfield Digby, M.P., formally opened a new dry dock which has been constructed for Messrs. Brigham and Cowan, Ltd., at South Shields. This valuable contribution to the ship-repairing facilities of the North East Coast of Great Britain incorporates several novel features in graving dock design and is the subject of our leading article for this month.

The new dock has been built on the South Shields frontage of the River Tyne, about two miles from the river mouth, and is a larger and improved edition of a dry dock which the late Robert Brigham had for some years intended to build on this same piece of land. The dimensions of the dock are related to the size of modern oil tankers and to the possibilities of the site. The character of the ground and the foundations were peculiar and presented problems of considerable difficulty. The Consulting Engineers, however, devised an ingenious and economic method of accommodating these conditions. As a result, they were able to produce a comparatively cheap structure, built into ground which has suffered no disturbance, the construction being in every way as strong and secure as its more costly prototype.

There are in this dock a number of other features making for economy; for example, the use of precast reinforced-concrete ribbed walls, the incorporation of concrete into intimate contact with the hard boulder clay without any intermediate blinding layer, and the formation of jetties and wharfages along the river frontage by supporting a monolithic reinforced-concrete deck slab upon broad-flanged-beam steel piles, a type of construction which compares very favourably for speed, strength and economical first cost with more complicated methods of wharf construction found elsewhere.

As is well known, many British ship-repairers and port authorities are deterred from expanding their installations because of the very great expense which can be incurred in new building works. This latest dry dock at South Shields and others recently built in the United Kingdom and on the Continent have, by the novelty of their design, effected appreciable advances in economy over the traditional methods. In view of the considerable increase in the size of modern tankers and the continuing shortage of large graving docks, this is a factor of great importance.

**Historic Occasion for the Panama Canal.**

Sometime during this month a ton of cargo will be shipped through the Panama Canal which will mark a significant milestone in the operating history of this famous waterway. It will be the thousand-millionth ton of cargo to be shipped through the canal since it was opened to commercial traffic on August 15, 1914.

The Canal Administration is planning to take advantage of this occasion to call attention to the importance of the waterway to world commerce by a special programme. This will take place when the ship carrying the all-important ton of cargo makes its transit through the Gatun Locks on the Atlantic side of the Isthmus. A specially designed scroll will be presented to the master of the vessel, and replicas of this will be presented to all transiting ships moving through the Canal on that day.

In view of the international importance of the Panama Canal, the programme is planned to emphasise its service to world shipping, and various interests directly concerned with the transit of vessels from the Atlantic to the Pacific will be invited to participate. Also taking part will be a representative group of employees of the Canal administration, whose duties relate to the expeditious handling of shipping through the Canal.

Owing to the present unsettled conditions prevailing in the shipping industry, however, it has not been possible to predict in advance the exact date on which the thousand-millionth ton of cargo will be moved through the Canal. Neither will the exact nature of the cargo be known until the vessel on which it arrives has been identified.

During the forty-two years that the Canal has been in operation, approximately 260,000 ships of all categories have passed through between the two oceans. Of these, over 190,000 have been sea-going vessels of more than 300 tons net. The resurgence of world commerce and shipping through the Canal since the end of World War II has been one of the outstanding features of its history to date. Approximately 350,000,000 tons of cargo have been shipped in the post-war decade, well over one-third of the total handled. The past fiscal year, ended June 30, marked the fifth successive year when new records in transits, tolls, net tonnage of vessels or cargo shipments for commercial traffic were established. Shipments totalled 46,301,354 long tons, exceeding by over 4,500,000 tons the total shipments for any previous year.

**Developing the Shannon Estuary.**

The article on "Great Ships and Their Terminals" which appeared in our last issue has aroused wide interest. We are glad to publish, on a following page, a letter from Colonel P. de H. Hall who was, until a short time ago, Chief Engineer of The Anglo Iranian Oil Company and is thus qualified to speak with authority from the Oil Industry's point of view.

At first glance it might appear that the Shannon Estuary is lacking in that the amount of oil required in Ireland is strictly limited. We suggest that this is a matter of minor importance. The same might be said of Aden or the ports in Syria and Palestine. It is European consumption that is involved. Would the siting of the point of discharge of what Colonel Hall calls "the floating pipe line" in the Shannon Estuary mean a cheaper and more dependable supply of oil or not? That is the point.

We all have oil very much in mind at the moment but that should not cause us to overlook the possibility of establishing a Free Port for Northern Europe which can measure up with the proposals for the Free Market group of nations now engaging attention.

**American Dock Labour Strike.**

It is unfortunate that at a time of international crisis in the shipping world the strained relations between the employers and longshoremen of the Atlantic and Gulf ports of the U.S.A. should break down so completely as they did last month. Despite representations to the dockers that they should try for a settlement, the International Longshoremen's Association called its members out on strike at midnight, 15th November, following a deadlock in negotiations for a new collective wage agreement between the I.L.A. and the New York shipowners. Previously, separate agreements have been made between dockers and port employers at the various terminals, though the rate paid at New York was accepted as the general basis.

## *Editorial Comments—continued*

The strike, which spread to all the major ports on the Eastern seaboard, and affected some 60,000 longshoremen, was the most extensive port strike ever known in the history of the United States. The main disagreement between the two parties centres on the demand of the I.L.A. that the agreement should apply to all the ports where it has members, but the New York shipowners have denied their competence to negotiate for any other port than New York, and have obtained a " restraining order " from a court enjoining the I.L.A. to drop that particular demand. Other issues at stake are the union's claim for an eight-hour day for any man accepted for work, and for a limitation on the size of slings.

On the 24th November, eight days after its commencement, a New York court issued an injunction under the Taft-Hartley Act, suspending the strike and ordering a ten-day " cooling-off " period. This period was later extended by the court to 12th February, 1957, thus using the full eighty days which the Act allows. The injunctions were issued on the authority of the President of the United States, who had just previously appointed a board of enquiry into the dispute. Efforts are now being made by Government labour officials to persuade the union and the employers to renew realistic negotiations. If the eighty-day injunction period expires without the parties reaching agreement the strike may legally be resumed.

In view of the increasing apprehension over the shortage of shipping caused by the blocking of the Suez Canal, there is urgent need to utilise all available vessels to the greatest possible extent. One obvious means to this end is to increase the speed of turn-round of ships in port. It is to be hoped, therefore, that a satisfactory solution to the present dispute will be achieved and further disruption avoided.

# Topical Notes

**U.N. Report on Oil Pollution.**

The United Nations Secretariat has issued " Pollution of the Sea by Oil," the results of a questionnaire addressed to 42 countries. The document, which can be obtained from sales agents for U.N. publications (price 11s.) deals with five aspects of the problem: Extent, studies and research; facilities in ports; facilities in ships; instructions concerning methods of avoiding pollution; and the system of regulations.

Regarding the extent of pollution, Norway stated that pollution has been most frequent in the Oslofiord, along the Skagerrak coast and at the entrance to the port of Bergen. There is a fair amount of pollution in waters other than harbours. The inspector assigned to the Skagerrak was the only one who said pollution was harmful to fisheries. High salinity causes fish eggs to float and destruction caused by oil is probably very great.

Sweden reported pollution of a fairly considerable extent at various places along the whole coastline from Haparanda to Strömstad. The most extensive damage was reported from Gotland and the west coast, but considerable pollution had also been observed at many other places, especially in the skerries outside Stockholm, along the east coast, the Blekinge coast and the eastern and south-eastern coast of Skane.

Denmark had not made any studies, but Germany reported pollution of all coasts, North Sea and Baltic, and that the main originators are tankers which discharge residues after washing their tanks, especially immediately before docking times to avoid tedious and costly cleaning in the ports.

Pollution is not widespread in Spain. A few traces have been reported at Cadiz and attributed to the heavy traffic through Gibraltar. Pollution at Corunna was reported due to tank cleaning on board vessels, especially fishing craft. Italy reported serious and persistent pollution at Savona, Genoa, Bari, Ravenna and Venice and less serious pollution at other ports, according to the extent of tanker traffic.

No serious problem exists off the coasts of Canada, due to the relatively light density of shipping. In the United States conditions have been reported as satisfactory except for a few areas. Venezuela reported that contamination extended to Lake Maracaibo to the west and Bergantin Bay and Pozuelos Bay to the east. Argentina reported serious pollution, which might endanger the port at La Plata. To overcome this state of affairs efforts are being made to enlarge and improve the installations for the filtering of industrial waste; to provide a channel independent of the port area; to improve the control of loading and unloading; and to clean the surface of the sea.

The New Zealand coastline is little affected and what pollution has occurred has been confined to the accidental discharge of oil from ships in port. Australia and the Philippines have not made studies of the problem, but in Japan researches into recent damage have been conducted. In China the Kaohsiung Harbour Bureau has set up a team to investigate pollution and has asked the Chinese Government to form a national committee.

In the section devoted to facilities in ports the Netherlands, Belgium, the United Kingdom, France, Canda, the United States and Venezuela are prominent, the details for the United Kingdom and France being particularly comprehensive. Similarly, in the section for facilities in ships, the information provided for British vessels reflects the trouble and expense taken to deal with the pollution problem. A table for vessels of 500 tons gross and over fitted with oily water separators gives 172 passenger ships, 671 cargo vessels and 18 tank ships, 11 of the latter being engaged in whaling and the remainder being tankers which use separators when pumping bilges.

France reported that about half their passenger and dry cargo ships have separators. As the International Conference on Oil Pollution held in London in 1953 showed, however, that separators were a somewhat ineffective means of preventing pollution, the use of them appears to be tending to decline. Similarly, although the United States reported that 65 passenger, 267 dry cargo ships and 11 tank ships used separators, they stated that no entirely satisfactory separator has been developed and that as the science of oil refining has progressed the gravity of residual fuels has gradually approached that of water so that the problem of separation has become more difficult.

**Committee on Safety in Dock Work.**

The preparation of a Code of Practice on safety and health in dock work was begun this month by an experienced committee of the International Labour Organisation at their headquarters at Geneva. The Committee had before them a preliminary draft in nineteen chapters, beginning with general rules and concluding with miscellaneous provisions on reporting and investigation, drinking water, berthing and shifting ships, hand tools and broken cargoes. The other chapters deal with such matters as access to ships and holds, loading and unloading machinery, transport equipment, personal protection, first aid and training.

Sixteen experts from fourteen countries were convened to take part in the meeting, which is expected to last until 22nd December. Mr. W. R. Hockaday, Deputy Senior Engineering Inspector of Factories, United Kingdom Ministry of Labour and National Service, was elected Chairman. Mr. J. H. Obrink of the Swedish Royal Board of Shipping and Navigation was appointed reporter.

In November, Mr. Hockaday was also Chairman of a meeting of eleven experts on the standardisation of certificates and registers relating to the text and examination of lifting machinery and gear used in the loading and unloading of ships. This Committee recommended that countries should adopt six certificates and a register based on those used in Canada and other countries. It expressed the hope that all countries would use certificates and registers based on these standard forms as early as possible, regardless of whether they had ratified the I.L.O. Protection against Accidents (Dockers) Convention of 1932. It further emphasised that " the universal adoption of the system of tests, examinations and inspections implicit in the use of these forms would contribute effectively to the prevention of accidents in dock work, and promote the development of reciprocal arrangements in these matters."

# Large Dry Dock at South Shields

## Special Features to Reduce Costs

*(Specially Contributed)*

**Introduction.**

IN September of this year Mr. S. Wingfield Digby, M.P., Civil Lord of the Admiralty, formally opened a new dry dock which has been constructed for Messrs. Brigham & Cowan Ltd., at South Shields. This dock is particularly intended to service the ever-growing tanker fleets and incorporates novel features of design[1] which have resulted in exceptionally low capital cost. A general view is to be seen in Fig. 1.

Prior to the last war the small number of large British dry docks in private hands existed principally to serve large passenger liners. Since then the increasing sizes of nearly all classes of vessel and especially those of oil tankers have led ship repairing firms to review their existing facilities and plan new works and extensions to keep pace with the shipping developments. Present shipbuilding programmes include some oil tankers larger than 40,000 tons deadweight but there is already a large and steadily increasing number of vessels between 20,000 and 40,000 tons deadweight, vessels which can enter most major ports without difficulty and which are likely always to take an important part in oil transport and to produce a considerable and continuing demand for repair dock facilities. Messrs. Brigham & Cowan decided therefore to provide for vessels up to 38,000 tons deadweight, the dimensions of the dock being 715-ft. in length, 95-ft. width at the entrance and a depth of 25-ft. over the sill at high water of spring tides. It is interesting to note that four other concerns faced with the same choice at about the same period made a similar decision, the new docks of Smiths[2] and Swan Hunter on the Tyne and Nordseewerke and Burmeister and Wain on the Continent all being 715-ft. long or thereabouts.

Many existing yards are too confined naturally or by other installations to permit major extensions but in this instance the owners were fortunate in having had the foresight to acquire piecemeal over a number of years a valuable and practically undeveloped site adjoining their main works. Even this area was restricted in relation to the developments planned and in the event had to be enlarged to the maximum possible extent at the cost of realigning a public road running on an embankment on the landward side in order to permit the new dock to be the length desired. The general arrangement of the dock (Fig. 2) illustrates how neatly the dock fits into the land available. The alignment at 45 degrees to the river frontage both suits the site and provides an easy approach for ships when docking.

The depth of water provided is somewhat less than has been the practice with docks of comparable size in the past but it must be remembered that the docking draughts to be expected when handling bulk carriers are much less than the corresponding requirements for passenger vessels. It was therefore quite logical for the owners to suit the provision made to the trade expected and thereby keep the capital expense to a minimum, the depth of a dock being generally the most significant dimension when cost is considered.

**The Body of the Dock.**

In this particular instance, much turned on the overall depth of dock construction being kept as small as possible as will be seen when the relation between ground conditions and the wall and floor designs adopted is noted.

[1] "Dock and Harbour Authority," November, 1953, p. 211.
[2] "Dock and Harbour Authority," September, 1954, p. 153.

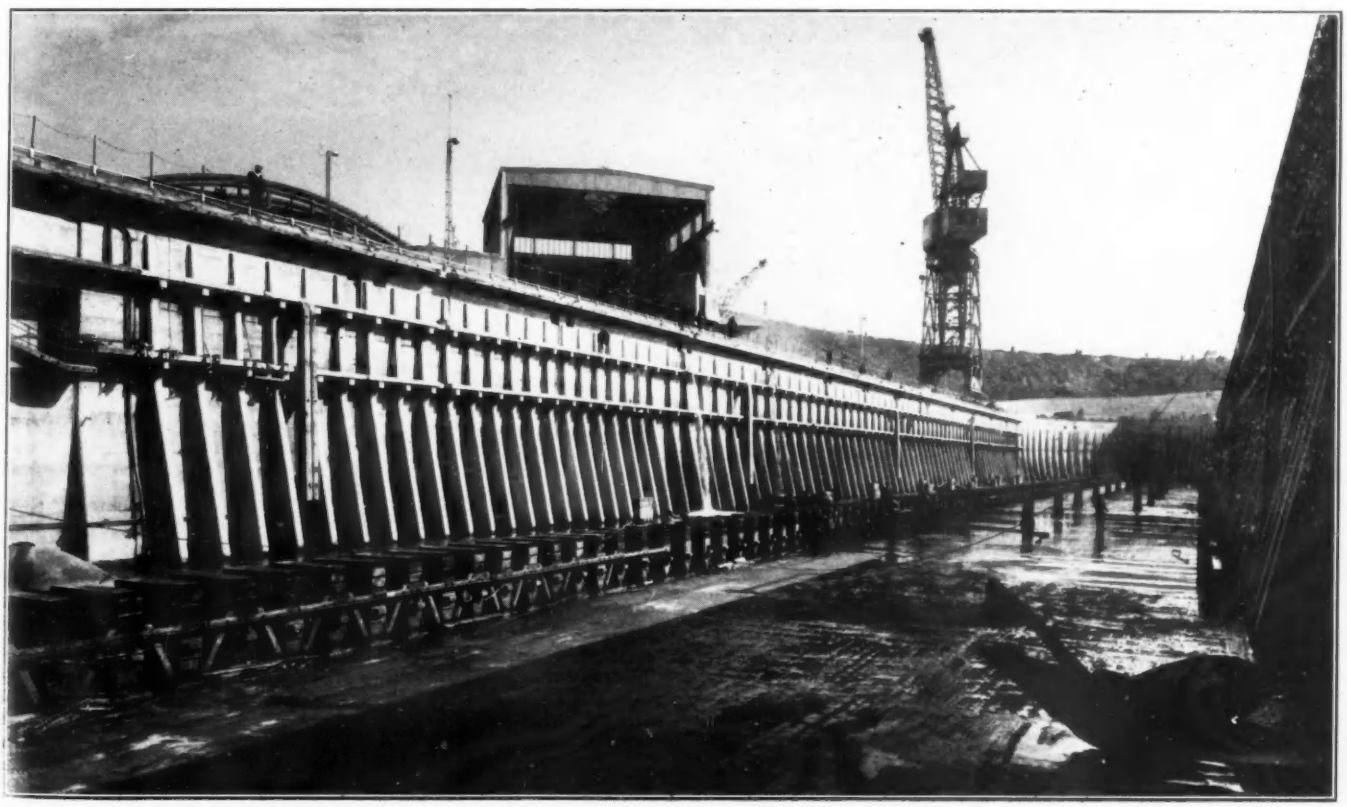


Fig. 1. General view of dock.

## *Large Dry Dock at South Shields—continued*

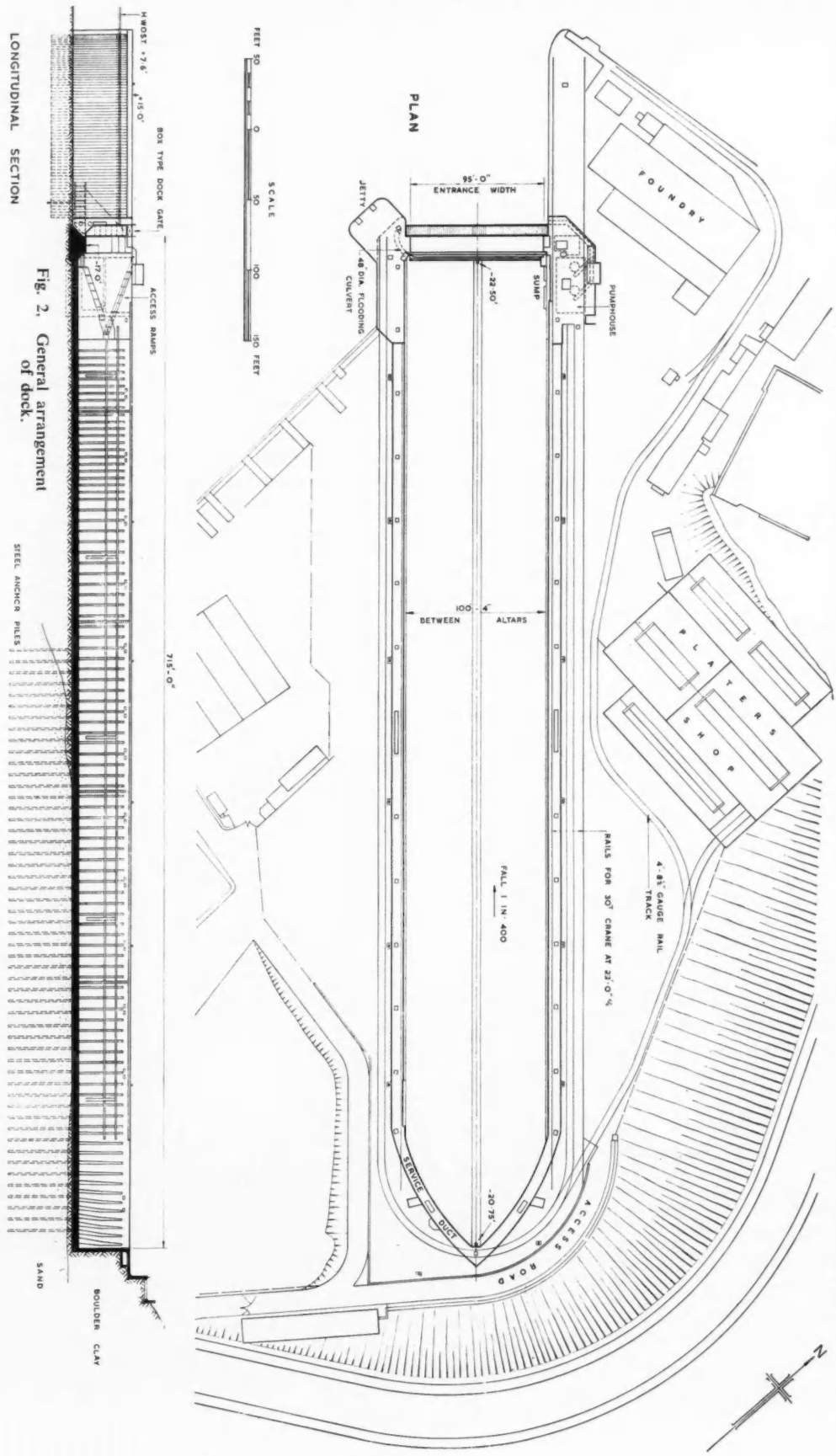



Fig. 2. General arrangement of dock.

Deposits of boulder clay are general over the site. Borings revealed firm clay to a considerable depth below overlying fill in the riverward half of the dock but over the remainder of the dock area showed an extensive water-bearing sand deposit with its upper surface at about the proposed dock floor level with stiff clay overburden to ground level. The water from the sandy material stood in the boreholes at about mean sea level and was subject to very slight tidal variations indicating some underground connection with the river.

The assessment of the strength and reliability of the stiff boulder clay was of primary importance in the formulation of an effective and economical wall design. As a result of a careful study of local records and laboratory tests it was decided that given correct technique during construction the dock body could be excavated in open cut leaving the clay side walls standing vertically without support while the permanent side wall construction proceeded.

This having been established a simple and economical wall construction was adopted. Precast reinforced concrete cantilever buttresses occur at 5-ft. or 7-ft. 6-in. centres (depending on the ground conditions) and these members are set into the floor concrete which is suitably reinforced to provide a base. Between the buttresses and connected to them by horizontal reinforcing bars are concrete panels 2-ft. thick cast directly against the clay face. In the photograph (Fig. 3) this wall construction can be seen in progress against a clay bank standing some 40-ft. high without support.

The buttresses were cast on prepared beds formed on completed sections of the dock floor. The weight of a unit was limited to 10 tons, it then being easily handled from the forms by a travelling Scotch derrick crane (Fig. 4).

The typical cross section of the dock (Fig. 5) indicates other features of the wall construction. A duct for dockside services is provided just below cope level. This has a structural function as a beam connecting the heads of the buttresses and acting as a horizontal stiffening member to distribute inequalities of pressure and local loads on the buttress system. Ports in the dock face of the duct allow temporary service connections to be made.

Altars are provided at three levels. The topmost is formed in the concrete of the cope; the two lower ones are provided by precast concrete planks bolted to projections of the buttresses.

Such a wall design is novel as here employed. Previous reinforced concrete work in dry dock construction has generally been limited to com-

[3] "Dock and Harbour Authority, February, 1947, p. 258.

## *Large Dry Dock at South Shields—continued*

paratively light reinforcement of masswork[a]. The opportunity for the use of the technique has come not only from the nature of the ground but also from the employment of a floor design which is in some respects of equal novelty. The need for structure weight in resisting upward hydrostatic forces beneath the floor which normally calls for a closely integrated masswork design of walls and floor has here been avoided.

The floor design has to be considered in two separate instances, the first the riverward half of the dock where stiff clay occurs at floor level, the second the landward half where the waterbearing sand is located.

In the clay area the assumption has been made and vindicated by practice that significant hydrostatic pressures will not develop between floor and clay. Taking also into account the high bearing capacity naturally available for carrying ship loads a comparatively thin floor of 4-ft. average thickness has been employed.

In the area of waterbearing sand the ground is such that relief of the hydrostatic pressure cannot be relied upon to be effective permanently and the floor consequently has to resist this upward pressure due to water whose natural standing level would be 22-ft. above the bottom of the dock. To overcome these conditions a concrete floor no thicker than that constructed over the rest of the dock has been pinned to the strata beneath by means of 10-in. x 10-in. H Section steel piles 45-ft. long. The piles are anchored into the ffoor concrete which is lightly reinforced to transmit the loads to them. A working load in tension of 32 tons per pile is used, piles at 8-ft. centres in each direction being required. Extraction tests on individual piles gave failing loads of the order of 100 tons. In some areas the piles perform a dual function by supporting ship loads as well as restraining hydrostatic pressures.

During construction the water in this difficult sandy area was lowered and controlled by pumping from deep 6-in. tube wells installed along both sides of the dock at 25-ft. centres. These wells effectively drew the water in the sand down below formation over the whole width of the dock. Conditions were then so satisfactory that the same general sequence and manner of construction as adopted in the clay area could be carried forward. Only in two limited areas was subsidiary well-pointing necessary to maintain the dryness of the bottom.

### The Dock Entrance.

The dock entrance is situated athwart the original line of the river wall and all the works there were constructed in steel sheet pile cofferdams.

The wall on the south side is a mass concrete structure founded directly upon the boulder clay. In it is embodied the 48-in. diameter main dock filling culvert, the flow through which is controlled by a sluice valve at the discharge. An emergency closure is provided at the intake by a flap valve.

The dock sill is 12-ft. thick and is splayed on its outer side forming an apron which allows the gate to be lowered below sill level.

The pumphouse forms the north side of the entrance and lies wholly below cope level. It is remarkably compact, the pump floor being only 37-ft. x 19-ft. 9-in. in plan, the main dock sump lying immediately beneath. A gallery in the pump chamber carries electrical switchgear and auxiliary plant.

Structurally the pumphouse is a reinforced concrete box, the walls being generally 4-ft. thick. No waterproofing by asphalt or otherwise was specified nor were water bars employed at the construction joints, reliance being placed on good quality concrete and correct and simple treatment of joints.

### Pumping Plant.

There are two main pumps for dock dewatering which, when operating together, are capable of emptying the dock in 4½ hours under spring tide conditions, the volume to be handled being 2,100,000 cubic feet. With a medium sized ship in the dock the dewatering can be carried out in under 3½ hours, a time which the owners consider to be adequate for all normal purposes.

These units are 30-in. electrically driven vertical spindle centrifugal pumps. The discharge from each is taken into a 36-in. diameter concrete pipe constructed in the form of a siphon and embodied in the pumphouse structure. The invert at the crest of each siphon is above highest high water level and the discharge is below low water. Siphoning back into the dock after stoppage of the

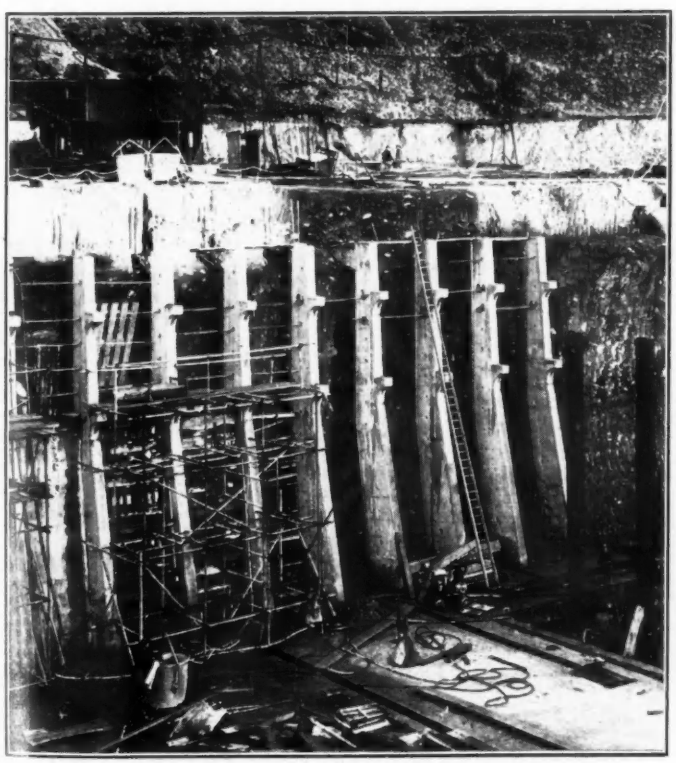


Fig. 3. Buttress wall under construction.

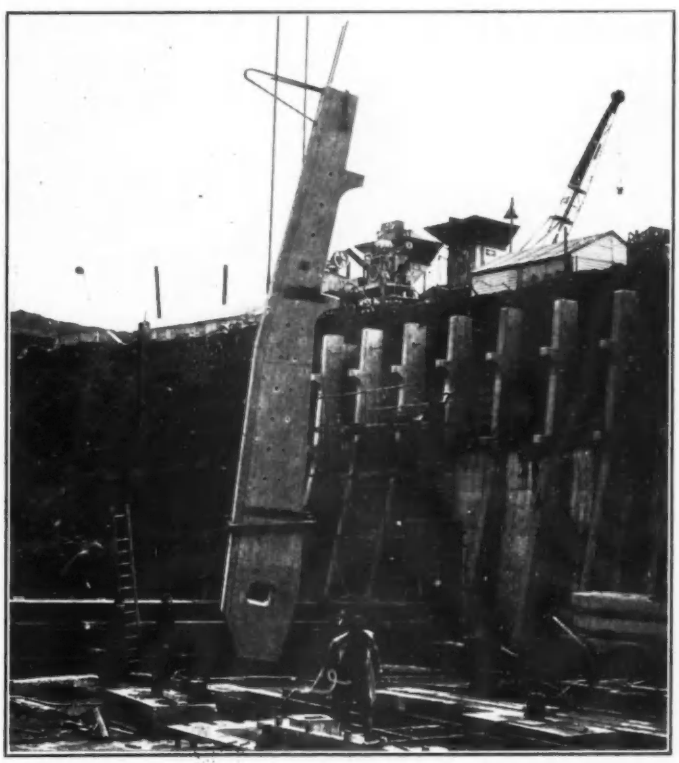


Fig. 4. Precast buttress being lifted.

## *Large Dry Dock at South Shields—continued*

pumps is prevented by hydraulically operated automatic air valves fitted at the crown of each siphon and actuated from oil pumps mounted on the main pump units. When these main pumps start up the oil pumps deliver oil to pistons on the air valves which keep them closed and allow the siphon to be completed. As soon as the main pumps stop the oil flow ceases and the air valves open destroying the siphon.

This discharge system eliminates sluice and reflux valves. In addition to a slight saving in first cost thereby, maintenance of the system is easier and hydraulic losses are reduced.

Two 10-in. electrically driven vertical spindle self-priming centrifugal pumps are installed for drainage and ballast service. The arrangements are such that either or both the pumps can be left to deal automatically with dock drainage flowing into the main sump or alternatively can draw water from the river for ballast supply along the dock side.

The suppliers of the complete pumping plant were Drysdale & Co. Ltd., Glasgow.

**Dock Gate.**

Following the modern trend the dock has been equipped with a Box or flap type of gate which is widely thought to be the most economical of the various types for a dock of this size in tidal waters. Advantages in cost over mitre gates, for instance, come not only from the gate and its operating machinery but from the simpler and more compact provisions which are required in the dock structure. The saving in dock length due to the elimination of gate recesses is of itself a significant factor.

The gate is an all welded mild steel cellular structure the principal dimensions being centres of end posts 98-ft. 3¾-in., height from underside of sill timber to top deck 30-ft. 2-in., moulded width 7-ft. 1¼-in. Flooding and buoyancy chambers are provided so as to minimise the pull required on the operating rope during normal operation and to allow control of buoyancy during stepping and unstepping. Six 21-in. dia. sluices are incorporated in the gate as auxiliary flooding ports for the dock.

Support for the gate is provided by four anchorage pivots (Fig. 6) fixed to the sill apron, upon which rest semi-cylindrical cast iron trunnion blocks bolted to the keel. There is no mechanical connection to hold the gate its own weight being sufficient to keep it on the pivots at all stages of normal use.

Operation is by an electrically driven haulage winch situated entirely below cope level in a pit formed in the pumphouse block. The winch rope is directed through fairleads to sheaves on the gate and thence to an anchorage just below cope on the opposite side of the dock, thereby providing a two part system of haulage. Provision is made for emergency operation by capstan.

To overcome the slow equalisation of dock and river levels in the final stages of dock flooding hydraulically operated push-off rams are included to give an initial opening movement against heads of up to 6-in.

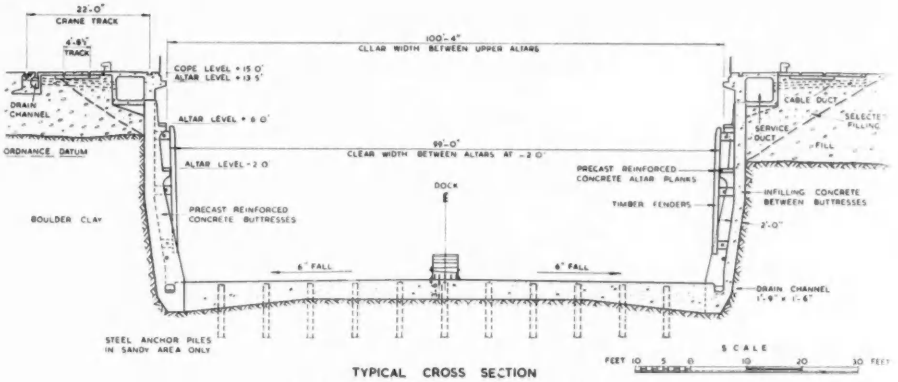



Fig. 5. Typical cross section of dock.

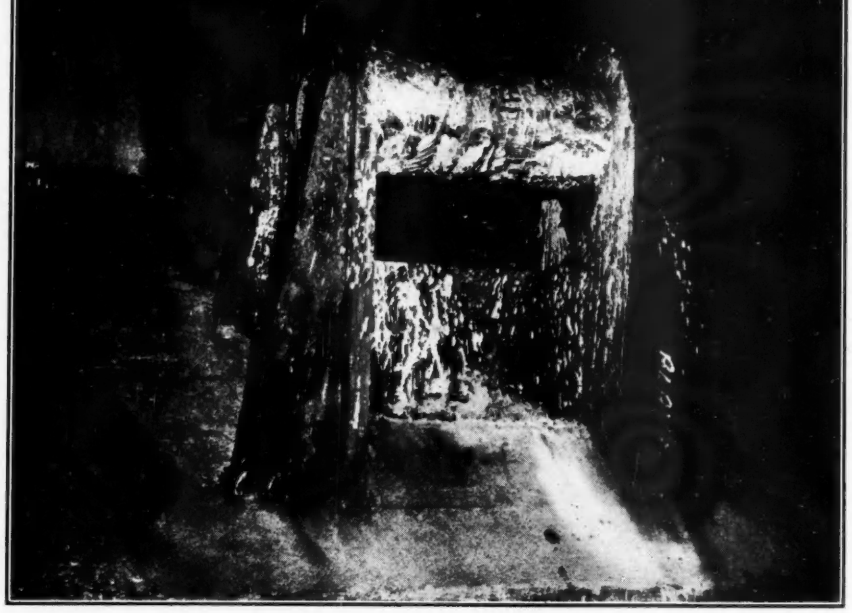


Fig. 6. Gate pivot.

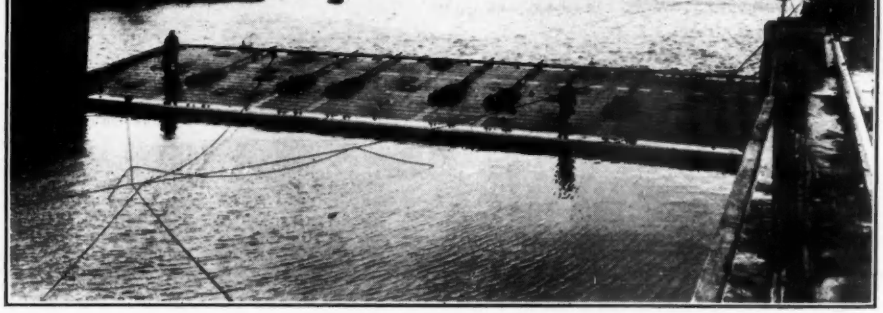


Fig. 7. View of gate during stepping operations.

## *Large Dry Dock at South Shields—continued*

Greenheart meeting timbers around the gate perimeter are fitted with a rubber angle on the outer edge as a supplementary seal. The fixed meeting face against which the timbers bear is formed by reinforced granolithic concrete members precast against machined steel shutters, set in place and keyed to the sill and sidewall concrete. So accurately were these cast and set that very little grinding of the face was necessary to produce a true surface.

The gate was fabricated complete by Head Wrightson & Co. Ltd., on a slipway at their Thornaby-on-Tees works, launched and towed to the new dock. Fig. 7 shows it in position at the dock entrance during the stepping operation.

**Minor Details.**

In any project of this nature, the treatment of the work in detail is frequently of great interest and certain minor features of this dock are worthy of mention.

Handrailing is provided round the cope, the owners having decided to follow the official recommendations in this respect. Staunchions formed out of 3-in. x $\frac{5}{8}$-in. mild steel flats ride upon pivots at cope level, slotted holes enabling them to be lifted and laid down below cope when required for docking operations or local access to a ship in dock. Safety chains link the staunchions. In combination with this handrailing a steel bar is arranged to run continuously round the dock at just above cope level forming a smooth surface for dragging ropes during docking and a convenient hitching point for small ropes. Similar bars run beneath the upper and middle altars to allow shores to be secured anywhere along the dock. These details may be discerned on the general view of the dock (Fig. 1).

Fixings to concrete have been designed almost without exception for easy renewal in the event of damage or corrosion. Bolts are not set in the concrete, but pass through cored holes formed during casting, hand pockets at the ends of the holes allowing locking nuts to be screwed on. Fenders, handrail stanchions and ladders are all fixed in this manner.

The electric supply to the main dockside crane comes from a single plug point at the centre of the crane travel. As the trailing cable unreels it lies in a groove formed by special cast iron covers to a drainage channel running alongside the rear crane track. This arrangement has the advantage in maintenance over continuous underground conductors and a travelling collector, and gives much greater ease of working than systems employing plug boxes more closely spaced and requiring plug changing as the crane moves.

**Ancillary Works and Equipment.**

Very substantial ancillary provisions have been undertaken to accompany the new dock.

The main crane is a Butters electric travelling monotower with a lifting capacity of 30 tons at a radius of 90-ft. Minor cranage around the cope and in the yard generally is supplied by two Smith 10-ton diesel rail cranes.

A new platers' shop constructed alongside the dock is specially designed to handle large prefabricated assemblies for bulkhead and other repairs. Such units can be handled during welding by a 30-ton electric overhead travelling crane and when completed can be carried by the crane out of the shop and within the reach of the travelling monotower. With the steady increase in ship size, prefabrication for major repairs is becoming an important technique for reducing time in dock and this installation is in the vanguard of this progression.

Extensions and improvements to the existing jetty facilities for repairs afloat have been constructed along Messrs. Brigham & Cowan's river frontage to allow vessels which use the new dock to lie alongside. A further service to ships entering dock has been provided by the conversion of an existing 150-ft. long dock into tanks for the storage of fuel and diesel oil.

**General.**

The period occupied by the developments described was from December, 1953, to August of this year. The dock itself was virtually complete within two years of the commencement and actually came into use early in the year.

Marples Ridgway & Partners Limited of Lygon Place, Victoria, S.W.1, were the main civil engineering contractors.

The consulting engineers to Messrs. Brigham & Cowan Limited are G. Maunsell & Partners, of 7, Cleveland Row, Westminster, S.W.1.

# Correspondence

From Colonel P. de Havilland Hall, D.S.O., M.C., B.Sc., M.I.C.E.

Dear Sir,

**Great Ships and their Terminals**

In your November issue, under the above heading, Major Waller poses a problem which must surely be exercising the minds of all ship owners, and for that matter shipbuilders, too. This is the lack of ports having sufficient depth of water to accommodate the large modern tanker.

Thirty years ago the Petroleum Industry worked broadly on the basis that normally the right place to refine oil was where it was produced, with the consequence that tankers from 10 to 12,000 tons capacity were quite large enough to transport economic parcels of refined products, and such vessels usually had a draught of less than 30-ft.

Gradually economic effects, the big increase in oil consumption and strategic considerations, heightened by the last war, made it necessary for oil companies to alter their entire policy and do most of their refining near to the markets.

The result of this change of policy has largely converted the tanker into a single purpose ship, i.e. a carrier of crude oil, a kind of floating pipe line between the oil fields and the refineries. It was a natural consequence of increased demand for oil and this change in policy coupled with the economies to be effected by using big ships that brought about the rapid increase in the size of tankers, which has been a startling post-war development.

This increase in size has brought with it many difficulties for shipowners and ship builders alike. Length and beam may be at some ports a limiting factor, but the draught of these big ships make them difficult to accommodate except in a very few deep water natural harbours.

One of the results of this lack of deep water harbours, with consequent limitation of the draught, has been to force the ship builders to produce ships of great length, and enormous beam, but of shallow draught, surely an uneconomic proportioning of the dimensions.

In some ways the tanker owner is much more fortunate than the ordinary cargo ship owner. He does not require a lot of dock equipment, cranes, warehouses, railway sidings and the like. All he needs is to get his tanker alongside where he can get connected to a pipe line. In some cases submarine pipe lines and buoys are used, but shipmasters like to get tied up to something stable like a jetty or dolphin and to find that jetty or dolphin in a sheltered bay or estuary.

Now here is quite a problem, and one that is going to increase in importance very rapidly. Major Waller points the way to its solution, it is study geography. If one studies the coastline of almost any industrial country it will be found that wherever there is deep water close inshore, and a sheltered roadstead and a reasonably flat land space at hand there sooner or later has come industrial development.

The Shannon Estuary is a case in point; it has all the requirements of a good commercial port but, due to the smallness of the Irish market, it could not in the forseeable future be a financial success except as an entrepôt.

The correct picture seems to be an oil refinery at Foynes served by Giant Tankers, the products being distributed by small coastal tankers, or inland water transport. Of course, refineries must have storage behind them to enable a steady inflow of crude oil to be provided and at the same time to store the finished products till the market is ready to take them. The suggestion to use underground storage appears very attractive, but is obviously a point that can only be settled on expert geological advice.

8, Crescent Road, Yours faithfully.
Kingston Hill, Surrey. P. de HAVILLAND HALL.

# Electrical Distribution as applied to Docks

## Introduction and Section I (Estimation of Power Requirements)

By C. H. NICHOLSON, M.I.E.E., M.I.Mech.E., F.R.S.A.

**Introduction**

FACTORS which have influenced the distribution of electrical energy on dock areas during recent years are the increase in the size of the vessels using ports, the need to decrease the time taken in the turn around of shipping, the substitution by electrical operation of other forms of power such as steam and hydraulic and lastly, the general use of alternating current for electrical power services.

Dealing with the above items in some detail: The increase in the size of vessels coupled with the need for decreasing the time in port in order to increase the speed of discharge and/or loading, has increased both the physical dimensions, capacity, and the speed of operation of cranes. As an example, forty years ago the main equipment of a general purpose quay would have been cranes of 1½ to 2 tons capacity having a radius of 40/50 feet and a jib head height in the range of 50/60 feet from quay level. The hoisting motors had a rating of from 30 to 40 horse power and the slewing and travelling motors about 6 to 8 horse power each. A similar quay to-day is equipped with dual capacity cranes having a maximum capacity of 6 tons at 150/200 per minute requiring hoisting motors of from 90 to 120 horse power. Due to the larger dimensions and radius of the cranes, the slewing, travelling and luffing motors may be of from 15 to 25 horse power. Other types of plant used on docks causing large increases in the demand for electrical energy are grain silos due to the substitution of mechanical elevators by electro-pneumatic unloaders. The demand of electrical energy by an electrically-driven mechanical bulk grain elevator dealing with 120/150 tons per hour is in the order of 25 to 30 horse power, whereas a pneumatically operated plant dealing with the same quantity of grain per hour requires about 160 to 200 H.P. depending upon the height of lift.

The large increase in the use of mechanical unloaders for bulk materials such as iron ore, phosphates, sand etc., is a further source of large energy demands, as for instance, an electrically-operated iron ore unloader using grabs having a capacity of 12 tons pay load operating at a hoisting speed of 250 feet per minute will require hoisting motors of 500 horse power.

Pumping plants have also increased in capacity in order to reduce the time required to " dry dock " vessels.

The general substitution of direct current by alternating current brings the problems associated with the necessity of dealing with very large currents at high voltages under short circuit conditions. The question also of the control and improvement of power factor is one which calls for consideration in view of the almost universal application of two-part tariffs.

In general, it may be assumed that all large docks should be supplied with electrical energy at high voltage alternating current in view of the power demands in order to minimise the use of excessively large cables and to reduce voltage drop, the text therefore refers specifically to such dock areas insofar as the electrical layout is concerned, but the items dealing with assessment of power demand, consumption, diversity factor, resistive voltage drop etc., equally apply to small direct current systems.

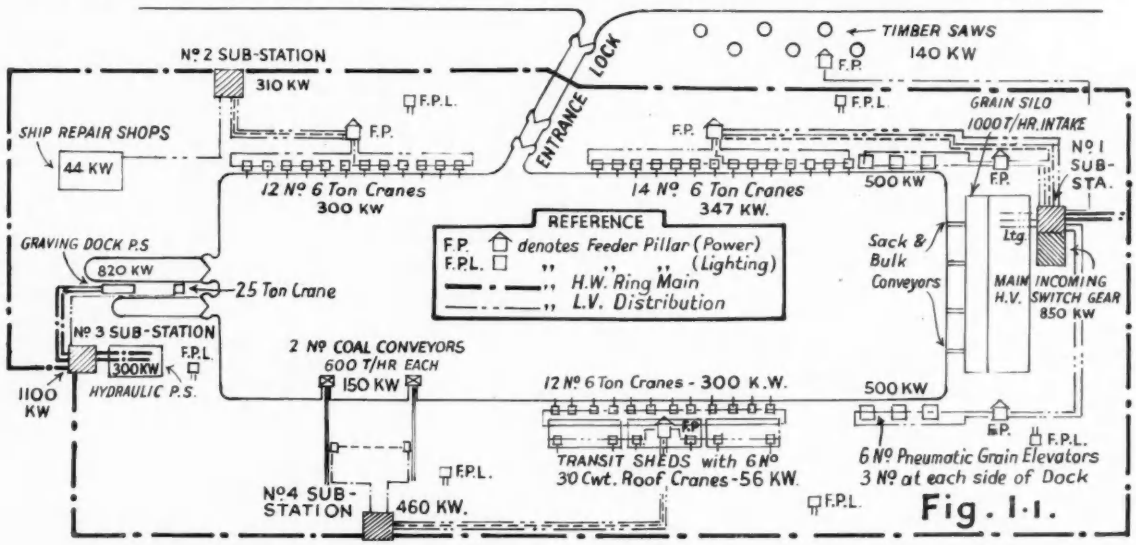



Fig. 1·1.

The salient points requiring consideration are:

(1) The magnitude of the load of the groups of appliances after the diversity factor has been allowed for.
(2) The total load after the diversity factor between groups has been allowed for.
(3) The centres of gravity of the group loads which in turn decide the number, position and capacity of the substations and/or points of supply.
(4) An estimation of the power factor of the group loads.
(5) The mVA rating of the various high voltage and low voltage units of switchgear taking into account feeder impedance.
(6) The location and capacity of the power factor equipment.
(7) The type of feeder and substation equipment fault protection apparatus.
(8) Fault protection apparatus.

In order to consider the above, it is essential that at an early stage a site plan is produced, see Fig 1.1.

### THE ESTIMATION OF POWER REQUIREMENTS SECTION I

Methods of estimating the power requirements of the usual types of plant in use on dock systems together with the relevant formulae and examples of application are given below:

**Electrically-driven Ram Pumps**

These are used generally for the purpose of supplying hydraulic services and pump water at high pressure in the range of from

## *Electrical Distribution as applied to Docks—continued*

600 lbs. per square inch to 1,000 lbs. per square inch and have capacities of from 100 to 700 gallons per minute.

The Brake horsepower required is given by the formula

$$\text{B.H.P.} = \frac{\text{H} \times \text{G.P.M.} \times 10}{33000 \times \text{Np}} \quad \ldots \ldots (1.1)$$

Where H = head in feet = Pressure in lbs. per sq. inch × 2.3

G.P.M. = galls per minute and Np = pump efficiency expressed as a decimal.

**Table 1.1**

**Ram Pump Efficiencies 600/1000 lbs. per sq. inch**

| * Pump BHP | Gallons per min. | Pump Efficiency | Motor Efficiency A.C. Induction | Overall Efficiency at Full Load. | Motor Power factor at Full Load. |
|---|---|---|---|---|---|
| 350 | 530 | 90% | 91.5% | 82.25% | 88% |
| 295 | 440 | 89% | 91% | 81% | 88% |
| 236 | 350 | 88% | 91% | 80% | 88% |
| 182 | 256 | 87% | 90.8% | 78.75% | 88% |
| 155 | 225 | 86% | 90.5% | 78% | 87% |
| 104 | 150 | 85% | 90% | 77% | 85% |

*At 850 lb/sq. inch.

Note. Pump Efficiences based upon a ram speed not exceeding 180-ft. per min.

Motor Efficiences and Power Factors based upon 10 pole motors.

Taking the pump particulars shown on Table 1.1, i.e. 530 gallons per min. at a pressure of 850 lbs. per sq. inch the pump B.H.P. is 350 at a pump efficiency of .9 and therefore the electrical input in kilowatts is

$$\text{Electrical input in Kilowatts} = \frac{\text{B.H.P.} \times .746}{\eta} \quad \ldots \ldots (1.2)$$

$$\frac{350}{.915} \times .746 = 286 \text{ K.W.}$$

Where $\eta$ = motor efficiency as a decimal.

### Electrically-driven Multistage Centrifugal Pumps

This type of pump is largely used for the provision of hydraulic services taking the place of the ram pump where large outputs are required. There is also considerable saving in floor space and cost. Multistage centrifugal pumps may be direct coupled to the driving motor and operate at speeds when direct coupled as high as 2900 (approx.) revolutions per minute as a maximum on 50 cycle electricity supply systems.

The B.H.P. required may be calculated from the formula 1.1 due regard being given to the pump efficiency.

**Table 1.2**

**Centrifugal Type Pump Efficiencies (excluding driving motor efficiency)**

| Capacity—Gallons per minute. | Speed R.P.M. | Head Feet | Type | Efficiency | No. of Stages. |
|---|---|---|---|---|---|
| 3000 | 720 | 15 | Mixed Flow | 80% | 1 |
| 3000 | 580 | 15 | Double Entry | 83% | 1 |
| 3000 | 960 | 100 | Double Entry | 85% | 1 |
| 60.000 | 480 | 100 | Double Entry | 89% | 1 |
| 3000 | 960 | 15 | Propeller | 77% | 1 |
| 60.000 | 290 | 15 | Propeller | 78% | 1 |
| 250 | 1475 | 2000 | Multi-stage | 62% | 12 |
| 1000 | 1475 | 2000 | Multi-stage | 80% | 12 |
| 250 | 2900 | 2000 | Multi-stage | 72% | — |
| 1000 | 2900 | 2000 | Multi-stage | 79% | — |

For the accuracy required to estimate the electrical demand the efficiency may be obtained from Table 1.2.

The horsepower required by a 13 stage centrifugal pump having a capacity of 800 galls. per minute against a head of 2,070 feet (900 lbs. per sq. inch) is given by

$$\text{B.H.P.} = \frac{800 \times 10 \times 2070}{33000 \times .78} = 622 \text{ H.P.}$$

$$\text{The K.W. demand} = \frac{622 \text{ H.P.}}{.92 \times 1.34} = 505 \text{ K.W.}$$

### Low Head Large Capacity Centrifugal Pumps

This type of pump is used for the purpose of pumping large quantities of water against low heads as for the purpose of dewatering graving docks, impounding etc. The capacity ranges from 10,000 galls. per minute to 60,000 galls. per minute.

The B.H.P. can be calculated from the same formula 1.1 as used for Ram Pumps using the efficiencies given by Table 1.2.

$$\text{The input H.P. is the} \frac{\text{B.H.P. of Pump}}{\text{Efficiency of the motor}} \quad \text{thus}$$

A Graving Dock Pump having a capacity of 36,000 gallons per minute against a head of 20 feet will require a motor having a brake horsepower of $\frac{20 \times 36000 \times 10}{33000 \times .81} = 270$ H.P. from formula 1.1

The efficiency is obtained from Table 1.2.

The efficiency of the driving motor may be obtained from Table 1.1 and is given as 91% therefore the kilowatt demand in respect of the pump when operating at full load is given by

$$\text{K.W.} = \frac{\text{H.P.}}{\eta \times 1.34} \quad \text{when } \eta = \text{motor efficiency at full load}$$

$$\text{thus K.W.} = \frac{270}{.91 \times 1.34} = 222 \text{ K.W.}$$

### Cranes

The main power demand in respect of a crane is the hoisting motion, the slewing, luffing and travelling being motored by relatively small power units. Average values for these, referred to a general cargo crane, are in the range of 10/15 B.H.P., 10/15 B.H.P., 8/10 B.H.P. respectively whilst the hoisting motor may be of from 60 to 150 B.H.P.

The B.H.P. for the hoisting motion may be calculated from the formula

$$\text{B.H.P.} = \frac{\text{T} \times \text{Vh}}{10} \quad \ldots \ldots (1.3)$$

Where T = tons load on hook Vh = hoisting speed in feet per minute. Thus a crane having a capacity of 6 tons at a hoisting speed of 200 feet per minute will require a hoisting motor of

$$\frac{6 \times 200}{10} = 120 \text{ B.H.P.}$$

Also a crane of the above capacity requires a 12/15 H.P. motor for the slewing motion and as the two motions may be operated simultaneously the total B.H.P. required is 135 H.P. neglecting the transient power demand for acceleration which is in normal practice fully met by the instantaneous overload capacity of motors, cables, switchgear, etc. As the luffing and travelling motions are of relatively small B.H.P. and are generally not operated simultaneously with the hoisting motion these may be neglected for the purpose of power computation. The calculation of the power requirements for a crane slewing motion are given below as an example of the procedure.

#### Calculation of Slewing B.H.P.

Hoisting Speed is 160-ft. per minute.
Load 7 Tons at 33-ft. Radius.
Slewing Speed is 2.5 R.P.M. or 520-ft. per min. (approx.).

$$\text{H.P. for Hoisting} = \frac{7 \times 2240 \times 160}{33000} = 76 \text{ H.P.}$$

$$\text{at 65\% Effy:} = \frac{76 \times 100}{65} = \mathbf{117 \text{ H.P.}}$$

### Rolling Friction

$$\frac{\text{Load} \times \text{Coef. of Friction}}{1/2 \text{ Roller Dia. ft.}} \quad \ldots \ldots (1.4)$$

$$= \frac{45 \times 2240 \times .005}{.334} = \mathbf{1510 \text{ lbs.}}$$

Note Load = wt. of hook load plus wt. of jib plus wt. of superstructure = 45 Tons.

### Turning Moment about Centre Pin

= Rolling Friction × Radius of roller path in feet . . . (1.5)

$= 1510 \times 4$

$= \mathbf{6040 \text{ lb. ft.}}$

## *Electrical Distribution as applied to Docks—continued*

**Acceln. Moment** of Load about the Slewing Axis

$$= \frac{\text{Load} \times \text{Radius} \times \text{Acceln.}}{g} \quad \ldots \ldots (1.6)$$

$$= \frac{7 \times 33 \times 2240 \times 1.88}{32.2}$$

$$= \mathbf{30300 \text{ lbs. ft.}}$$

**Acceln. Moment** of Jib about the Slewing Axis

$$= \frac{\text{Wt.} \times \text{Radius} \times \text{Acceln.}}{g} \quad \ldots \ldots (1.7)$$

$$= \frac{2\frac{1}{2} \times 18.375 \times 1.05 \times 2240}{32.2} = 3350 \text{ lbs./ft.}$$

**Acceln. Moment** of Remainder of Machine

$$\frac{36 \times 2240 \times 4 \times .284}{32.2}$$

$$= \mathbf{2840 \text{ lbs. ft.}}$$

**Total Moment**

$$= 6040 + 30{,}300 + 3270 + 2840$$

$$= \mathbf{42530 \text{ lbs. ft.}}$$

**Race Pinion** Pressure

$$= \frac{42450}{4.775} = \mathbf{8{,}900 \text{ lbs.}}$$

**H.P. developed** by Electric Motor

$$= \frac{8900 \times 2 - \times 4.775 \times 2\frac{1}{2}}{33000}$$

$= \mathbf{20.4}$ B.H.P. Note this is the total B.H.P. for friction and acceleration taking the gearing efficiency as 75% the total B.H.P. required is $\frac{20.4}{.75} = 27.25$ H.P. including that required for acceleration, the power required for friction is $\frac{6040}{42450} \times 27.25 = 3.9$ B.H.P., a 15 B.H.P. motor will produce twice full load torque for periods up to 1 minute in duration.

**Conveyors** (Belt)

Conveyors consisting of endless belts carried by idler pulleys are used for the purpose of delivering and transporting coal, grain and ores of various types. Coal and ore conveyors may have belts 60-in. wide and over 1,000-ft. between head and tail pulley centres, whilst grain conveyor belts are less in width (from 18-in. to 40-in. wide).

The Brake horsepower required by a belt conveyor is given by the formula

$$\text{B.H.P.} = \left(\frac{CTL}{1000}\right) \times 1.12 \text{ for level conveyors} \quad \ldots \ldots (1.8)$$

$$\text{and B.H.P.} = \left(\frac{CTL}{1000}\right) + \left(\frac{TH}{1000}\right) \times 1.12 \text{ for inclined conveyors} \quad (1.9)$$

Where C is a constant (table 1.3)
L = Length of conveyor in feet
T = Tons per hour (2240 lbs.)
H = Height material is lifted

**Table 1.3**

**Constant C**

| Belt width | Speed (max.) ft. per min. | Tons per hour at 100 ft. p.m. 100 lbs. per cu. ft. | Constant C. Material weighing 50 lbs. cu. ft. | 100 lbs. cu. ft. |
|---|---|---|---|---|
| 18-in. | 350 | 48 | .08 | .058 |
| 30-in. | 450 | 143 | .081 | .059 |
| 36-in. | 500 | 205 | .075 | .058 |
| 42-in. | 550 | 295 | .073 | .056 |
| 48-in. | 600 | 410 | .069 | .055 |
| 60-in. | 650 | 670 | .063 | .044 |

Example of calculation of power requirements for a dockside conveyor delivering coal weighing 50 lbs. per cu. ft. at the rate of 1,100 tons per hour and 800-ft. long having an incline giving a material lift of 50-ft.

From table 1.3 at a low speed of 350-ft. per min. in order to prevent coal breakage a 60-in. belt is required.

$$\therefore \text{B.H.P.} = \left(\frac{CTL}{1000} + \frac{TH}{1000}\right) \times 1.12 \quad \ldots \ldots (1.10)$$

$$= \left(\frac{.063 \times 1100 \times 800}{1000} + \frac{1100 \times 50}{1000}\right) 1.12$$

$$= (55 + 55) \times 1.12 = 123 \text{ B.H.P.}$$

A belt conveyor handling grain at the rate of 130 tons per hour and 1,000-ft. long would require an 18-in. belt and the brake horsepower $= \frac{.08 \times 130 \times 1000}{1000} = 10.4 \times 1.12$

$$= 11.64 \text{ B.H.P.}$$

and each tipper would require $\frac{\text{Belt width}}{10}$ B.H.P. i.e. in this case approximately 1.8 B.H.P.

A 60-in. conveyor 1,000-ft. long running at 300-ft. per minute and dealing with iron ore weighing 200 lbs. per cu. ft. would deliver 4,000 tons per hour and would require for a level conveyor 198 H.P.

**Apron Feeders**

Most Coal Conveyors have apron feeders and the power requirements of these may be estimated by the formula

$$\text{Chain Pull} = .1\ (2\ W_c\ L) + (W_m \times L) + D_s\ L \quad \ldots \ldots (1.11)$$

Where $W_c$ = Weight per foot run of the apron feeder
$W_m$ = Weight per foot run of the material
L = Distance between centres
$D_s$ = Skirt drag

**Values of $D_s$ Table 1.4**

| Depth of load in inches | 12 | 15 | 18 | 24 | 30 |
|---|---|---|---|---|---|
| Anthracite | 6 | 9 | 13 | 22 | 35 |
| Bituminous Coal | 6 | 9 | 13 | 22 | 35 |
| Coke | 3 | 5 | 7 | 12 | 20 |

Example of the method of calculation:

An apron feeder 100-ft. centres has a load 12-in. deep and 24-in. wide, speed 100-ft. per minute. Material, coal, weight of the apron per foot is 60 lbs., and the weight of the coal per foot is 100 lbs.

$$\text{Chain pull} = .1 \times (12000 + 10000) + 600 = 2800 \text{ lbs.}$$

$$\text{B.H.P.} = \frac{\text{lbs. pull} \times \text{feet per min.}}{33000}$$

$$\text{B.H.P.} = \frac{2800 \times 100}{33000} = 8.45 \text{ B.H.P.}$$

Assuming bearing efficiency of 75%

$$\text{B.H.P. of motor} = \frac{8.48}{.75} = 11.3 \text{ B.H.P.}$$

Note $600 = D_s$ from Table 1.4 multiplied by the length of the apron feeder.

If the apron feeder is inclined, then added to the above B.H.P., will be the power required to lift the material. Thus if the incline is such that the delivering end of the apron feed is 10-ft. higher than the receiving end i.e. an incline of 1 in 10 then the additional B.H.P. is given.

$$\text{by B.H.P.} = \frac{\text{T.H.}}{1000} \text{ and in the above}$$

$$\text{example this} = \frac{270 \times 10}{1000} = 2.7 \text{ B.H.P.}$$

$$\text{Tons per hour} = \frac{Wm \times Vc \times 60}{2240} = \frac{100 \times 100 \times 60}{2240} = 270 \text{ approx.}$$

In addition to the main conveyor belt or belts there is usually an outboard conveyor which may be telescopic together with the winches for lifting the delivery end and heel end of the outboard conveyor.

The outboard conveyor brake horsepower may be calculated in the same manner as the main conveyor, and if for instance using the previous example the tons per hour are 1100 and the outboard

## *Electrical Distribution as applied to Docks—continued*

conveyor is 50-ft. between centres and further and upward inclination can be adjusted to 18° maximum, the lift from the heel end to the delivery end of the conveyor is 50 SIN 18°.

$$= 50 \times .309 = 15.5 \text{ feet}$$

$$\therefore \text{B.H.P.} = \frac{(1100 \times .063 \times 50}{1000} + \frac{1100 \times 15.5)}{1000} \times 1.12$$

$$= (3.465 + 17.05) \times 1.12$$

$$= (20.515) \times 1.12$$

$$= 22.97$$

Regarding the winch and telescoping motors these are so relatively small and have such a large diversity factor that for the purposes of power computation they may be neglected.

Typical actual values of the brake horsepowers required for a conveyor designed to deliver 400 tons of run of mine coal per hour at a maximum shipping height of 40 feet and having a belt length of 1,000-ft. between centres.

| | |
|---|---|
| Main Conveyor ... ... ... ... ... | 85 B.H.P. |
| Outboard Conveyor ... ... ... ... | 10 B.H.P. |
| Outboard Telescopic Motor ... ... ... | 5 B.H.P. |
| Apron Feeder ... ... ... ... ... | 12 B.H.P. |
| Winch for the delivery end of the outboard conveyor | 12 B.H.P. |

### Mechanical Elevators

The brake horsepower required for bucket and belt elevators is given by the formula

$$\text{B.H.P.} = \frac{\text{Tons per hour} \times 2 \text{ (Lift in feet)}}{1000} \quad \ldots . \quad (1.12)$$

Example a bucket elevator lifts 150 tons of grain per hour to a silo floor 80 feet above the receiving end of the elevator

$$\text{B.H.P.} = 150 \times 2 \ (80)$$

$$= \frac{150 \times 160}{1000} = 24 \text{ B.H.P.}$$

### Pneumatic Elevators

The power requirements of pneumatic elevators is a function of the tons per hour delivered and may be taken for power computation purposes as 1.5 B.H.P. per ton per hour delivered. Thus a pneumatic elevator dealing with 200 tons of grain per hour will require a motor of approximately 300 B.H.P. including the seal motor.

In view of the small horsepower and the infrequent use of the Boom Motors these may be neglected in the estimation of Elevator B.H.P. for demand purposes.

### Wagon Hoists

These may be used for coaling purposes delivering the coal directly into the ship but they are more generally used for the purpose of transferring loaded or empty wagons from one ground level to another.

The horsepower required may be calculated from the formula

$$\text{B.H.P.} = \frac{\text{Tu} \times \text{V} \times 6.8}{\eta} \quad \ldots . \quad (1.13)$$

Where Tu = unbalanced load in tons
V = Speed in feet per minute
$\eta$ = Mechanical efficiency (percentage)

Example a wagon hoist lifts a loaded wagon having a gross weight of 40 tons, 50 feet in 1/3 of a minute, the weight of the hoist table is balanced, thus the unbalanced load is 40 tons.

From the above $V = 50 \times 3 = 150$-ft. per minute.

and the $\text{B.H.P.} = \frac{40 \times 150 \times 6.8}{65} = 628$ H.P.

and with a motor efficiency of 93% the K.W. input =

$$\frac{628}{.93 \times 1.34} = 504 \text{ K W.}$$

### Incline Hoists

The B.H.P. may be estimated from the formula

$$\frac{\text{T} \times 2240 \times \text{V} \times \text{Gr}}{33000 \times \eta} \quad \ldots . \quad (1.14)$$

When T = gross tons load V = speed of haul in feet per minute and gr = the gradient as a fraction or decimal when $\eta$ is the mechanical efficiency as a decimal.

Example a haulage having an incline of 1 in 10 a gross load of 40 tons including rope weight at a speed of 300-ft. per minute

$$\text{B.H.P.} = \frac{40 \times 2240 \times 300 \times 1}{33000 \times .6 \times 10} = 136 \text{ B.H.P.}$$

$$\text{K.W. input} = \frac{136}{.92 \times 1.34} = 110 \text{K.W.}$$

### Slipways

The B.H.P. may be calculated from

$$\text{B.H.P.} = \left(\frac{\text{T}_1 \times 2240 \times \text{V} \times \text{gr})}{33000 \times \eta_1}\right) + \left(\frac{\text{T}_1 \times \text{r}_t \times \text{V}}{33000 \times \eta_1}\right) \quad \ldots . \quad 1.15$$

Where $T_1$ = weight of vessel plus the weight of the cradle
V = the hauling speed in feet per minute
gr = the gradient as a fraction or decimal
$r_t$ = Resistance to traction of the cradle

which has a value of from 120 to 180 lbs. per ton depending upon condition of the Cradle bearings.

$\eta$ = Mechanical efficiency of the winch including gearing as a decimal

Example a slipway having an inclination of 1 in 15 a gross load of 1,090 made up of 1,000 tons vessel and 90 tons cradle.

$r_t$ = 150 lbs. V = 10 feet per minute
$\eta$ = .72

$$\text{B.H.P.} = \left(\frac{1090 \times 2240 \times 10 \times 1}{33000 \times .72 \times 15}\right) + \left(\frac{1090 \times 150 \times 10}{33000 \times .72}\right)$$

$$= 68.6 + 69$$

$$= 137.6 \text{ B.H.P.}$$

$$\text{K.W.} = \frac{138}{.92 \times 1.34} = 111.5 \text{ K.W.}$$

### Plant Diversity

The diversity factor may be defined as the ratio of the sum of the connected loads to the actual demand, thus an installation consisting of 10 cranes each having driving motors of 120 H.P. total, represents a connected load of $120 \times 10 = 1{,}200$ H.P. The actual demand for the group of cranes would not exceed 300 H.P., therefore the diversity factor is $\frac{1200}{300} = 4$.

There is a further diversity between groups of plant and this may be defined as the sum of the various group demands after diversity, divided by the total actual demand and this may vary in value from for two groups 1.1, 3 groups, 1.2, 4 groups and over, 1.3.

Thus to take an example based on Fig. 1.1 the plant consists of :

1 Group of 12 cranes each of 120 B.H.P. = 1440 B.H.P.

$$= \frac{1440}{\eta \times 1.34} = \frac{1440}{.9 \times 1.34} = 1190 \text{ K.W.}$$

1 Group of 12 cranes each of 120 B.H.P. = 1440 B.H.P.

$$= \frac{1440}{\eta \times 1.34} = \frac{1440}{.9 \times 1.34} = 1190 \text{ K.W.}$$

1 Group of 14 cranes each of 120 B.H.P. = 1680 B.H.P.

$$= \frac{1680}{\eta \times 1.34} = \frac{1680}{.9 \times 1.34} = 1390 \text{ K.W.}$$

6—30-cwt. cranes each of 40 B.H.P. each = 240 B.H.P.

$$= \frac{240}{\eta \times 1.34} = \frac{240}{.8 \times 1.34} = 223 \text{ K.W.}$$

6 Pneumatic Grain Elevators at 280 H.P. each = 1680 B.H.P.

$$= \frac{1680}{\eta \times 1.34} = \frac{1680}{.8 \times 1.34} = 1570 \text{ K.W.}$$

2 Coal Conveyors each of 107 B.H.P. = 214 B.H.P.

$$= \frac{214}{\eta \times 1.34} = \frac{214}{.85 \times 1.34} = 188 \text{ K.W.}$$

1 Grain Silo having total connected B.H.P. of 1500

$$= \frac{1500}{\eta \times 1.34} = \frac{1500}{.8 \times 1.34} = 1400 \text{ K.W.}$$

3—200 B.H.P. Hydraulic Pumps (accumulator controlled)

$$= \frac{600}{\eta \times 1.34} = \frac{600}{.92 \times 1.34} = 486 \text{ K.W.}$$

## *Electrical Distribution as applied to Docks—continued*

2—500 B.H.P. Graving Dock Pumps

$$= \frac{1000}{\eta \times 1.34} = \frac{1000}{.92 \times 1.34} = 810 \text{ K.W.}$$

One group of 30 Electric Saws each of 30 B.H.P.

$$= \frac{900}{\eta \times 13.4} = \frac{900}{.8 \times 1.34} = 840 \text{ K.W.}$$

One Ship Repair Shop having a total of 20 machines total B.H.P.

$$= 200 = \frac{200}{.85 \times 1.34} = 176 \text{ K.W.}$$

Lighting Load = 300 K.W.

Note that $\eta$ = the motor efficiency and is less for the lower B.H.P. machines, 1.34 is the factor (the reciprocal of .746) to convert H.P. to K.W. and the final K.W. obtained represents K.W. input to the plant. The total connected kilowatts are 9,763 K.W. also no allowance is made for the luffing, and travelling motions of cranes nor the beam hoist and slew of pneumatic elevators and conveyors as these are infrequently used and usually when the main plant is stopped.

Diversity factors of the groups are as follows:

12 Cranes diversity factor = 4 thus actual demand

$$= \frac{1200}{4} = 300 \text{ K.W.}$$

12 Cranes diversity factor = 4 thus actual demand

$$= \frac{1200}{4} = 300 \text{ K.W.}$$

14 Cranes diversity factor = 4 thus actual demand

$$= \frac{1390}{4} = 347 \text{ K.W.}$$

6 Cranes diversity factor = 4 thus actual demand

$$= \frac{223}{4} = 56 \text{ K.W.}$$

6 Grain Elevators diversity factor = 1.5 thus actual demand

$$= \frac{1570}{1.5} = 1046 \text{ K.W}$$

2 Coal Conveyors diversity factor = 1.25 thus actual demand

$$= \frac{188}{1.25} = 150 \text{ K.W.}$$

1 Grain Silo diversity factor = 1.65 thus actual demand

$$= \frac{1400}{1.65} = 850 \text{ K.W.}$$

3—200 B.H.P. Hydraulic Pumps diversity factor = 1.66 actual demand

$$= \frac{500}{1.66} = 293 \text{ K.W.}$$

2—500 B.H.P. Graving Dock Pumps diversity factor unity, actual demand = 810 K.W.

1 Ship repair shop (20 machines) diversity factor = 4 actual demand

$$= \frac{177}{4} \text{ 44 K.W.}$$

Lighting Load diversity factor = 1 actual demand = $\frac{300}{1} = 300$ K.W.

Thus the total K.W. demand if the demand of the groups are coincident is 4636 K.W. but in view of the fact that the demands are not coincident a group diversity factor is introduced and the total actual demand for the whole number of groups is the sum of the coincident demands after diversity multiplied by the group demand factor. The average group demand factor for a dock having plant similar to the above example is 1.3.

Thus the total dock maximum demand is $\frac{4636}{1.3} = 3560$ K.W.

and the total diversity i.e. $\frac{\text{connected load in K.W.}}{\text{actual max. demand in K.W}}$

for the whole dock is $\frac{9763}{3560} = 2.75$ approx.

The above calculations assume full working of all appliances which of course must be provided for when the maximum power requirements are being estimated. The dock diversity factor will in general become greater with an increase in the number of appliances using power intermittently such as cranes, hoists, capstans, haulages. Graving dock pumps, pneumatic elevators, hydraulic pumps, conveyors tend to reduce the diversity factor, the influence being the greatest in respect of graving dock pumps which have no diversity. Typical actual diversity factors for complete dock installations are given below:

| | Connected Load. | Actual Max. Demand. | Diversity Factor. | Remarks | Load Factor. |
|---|---|---|---|---|---|
| A | 8200 K.W. | 2340 K.W. | 3.5 | A large Dock, 50/60 acres water area Silo, Elevators, Cranes, large Graving Dock, Hydraulic Pumping Station. | |
| B | 25000 K.W. | 5800 K.W. | 4.3 | 2 large Dock systems with Silo, Elevators, Cranes, Hydraulic Pumping Station, 3 Graving Docks, 4 Slipways large industrial demand from consumers. | 38% |
| C | 2760 K.W. | 700 K.W. | 3.94 | Dock Water Area approx. 45 acres, Cranes, Capstans, Conveyors. | — |
| D | 1080 K.W. | 680 K.W. | 1.58 | Hydraulic and Graving Dock Service only. | — |
| E | 4869 K.W. | 460 K.W. | 10.6 | Medium-sized Dock having Cranes, Coaling Conveyors high diversity due to seasonal reduction in traffic. | 36% |
| F | 2516 K.W. | 365 K.W. | 6.9 | Ditto. | 34% |
| G | 27000 K.W. | 8660 K.W. | 3.1 | Large Dock having having large Graving Dock, extensive Cranage and Goods Handling facilities coupled with intensive passenger service. | |

The diversity factor for the various groups of plant comprising a dock installation are given below:

| | No. of Units. | Diversity Factor. |
|---|---|---|
| Cranes general cargo ... ... ... | 2 | 1.66 |
| | 3 | 2.0 |
| | 4 | 2.5 |
| | 5 | 3.33 |
| | 6 and over | 4.0 |
| Cranes Grabbing 30/40 operations per hour ... ... ... ... | 2 | 1.2 |
| | 3 | 1.4 |
| | 4 | 1.7 |
| | 5 | 2.0 |
| | 6 and over | 2.5 |
| Capstans ... ... ... ... | 10 and over | 10 |
| Elevators ... ... ... ... | 2 | 1.1 |
| | 3 | 1.25 |
| | 4 and over | 1.5 |
| Pumping Stations ... ... ... | 2 | 1.2 |
| | 3 | 1.4 |
| | 4 and over | 1.46 |
| Hoists and Wagon Tipplers ... ... | 2 | 1.1 |
| | 3 | 1.2 |
| | 4 | 1.34 |
| | 5 and over | 1.48 |
| Conveyors ... ... ... ... | 2 | 1.25 |
| | 3 | 1.6 |
| | 4 and over | 1.75 |
| Slipways ... ... ... ... | 3 and over | 1.6 |
| Grain Silos ... ... ... ... | | 1.65 |

(*To be continued*)

### Suggested Plan for New Swansea Dock.

A plan for the building of a new dock at Swansea with a new deep-water entrance channel has been prepared by the Swansea sea pilots, who formed a committee some time ago to consider the future of Swansea as a major port. According to statements issued by members of the committee, the plan is for a new dock to seaward of the present Queen's Dock, where tankers dock with oil for the National Oil Refineries at Llandarcy. It is claimed that, with a new deep-water entrance channel vessels up to 60,000 tons could be safely docked on all tides. In addition the Mumbles Roadstead affords a clear deep-water approach, with a safe deep-water anchorage.

# Radar on the New Waterway, Holland

## Chain of Stations from Hook of Holland to Rotterdam

*(Specially contributed)*

ON the 30th November, 1956, the first harbour radar chain in Holland, consisting of seven stations along the Nieuwe Waterweg, was formally inaugurated by H.R.H. the Prince of the Netherlands. This chain of stations along the 30 km. (approximately 19 miles) approach to the Port of Rotterdam makes it possible to survey the entire length of the shipping route from the entrance to the New Waterway at the Hook of Holland to the heart of Rotterdam.

**History of the Scheme.**

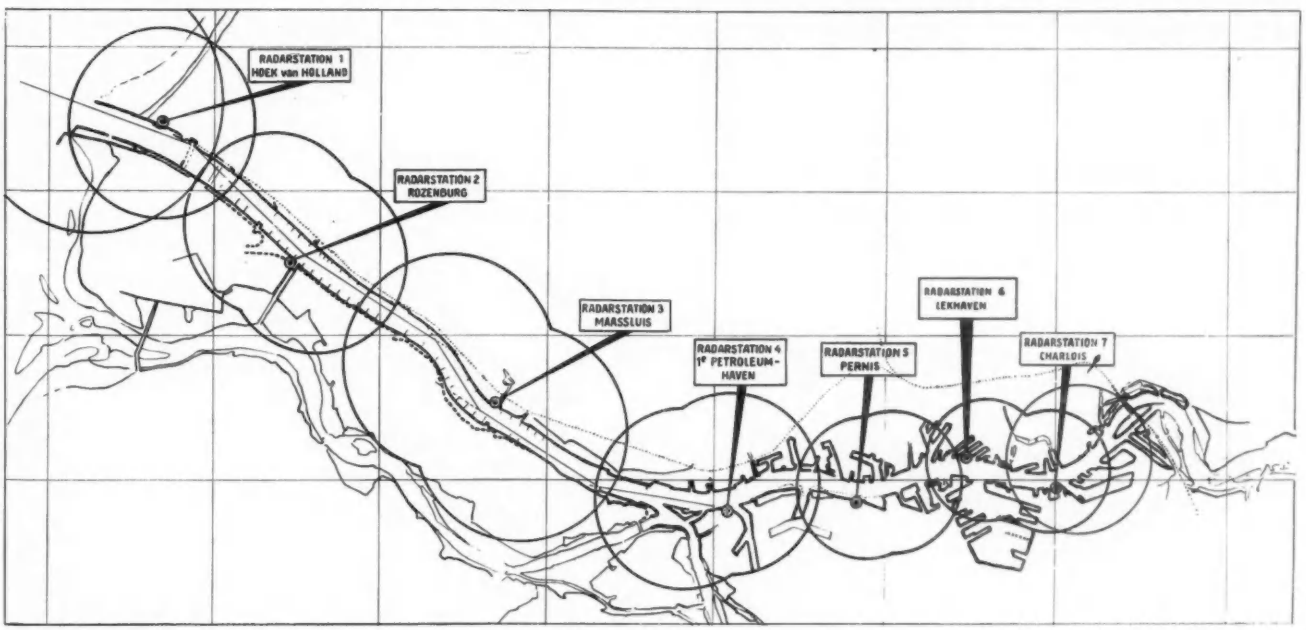
Before examining the radar system in detail, it may be of interest to outline the history of this ambitious project.

Early in 1947, the City Council of Rotterdam approached the Minister of Dykes and Waterways with a request to consider the desirability of installing harbour radar along the Nieuwe Waterway. As a contribution towards solving the problem, the National Committee on Radio Aids to Navigation submitted a report containing the draft scheme for a radio pilot service on the Nieuwe Waterweg. At the beginning of 1949 the Burgomaster of Rotterdam appointed a Radar Committee for the purpose of studying this report.

The Committee was presided over by the then Superintendent of Harbours in Southern Holland and many of its members were drawn from publicly or privately owned enterprises along the banks of the Nieuwe Waterweg. Among the groups represented were: the Pilot Service, the Board of Merchant Navy Captains and Officers, the City of Rotterdam, the National Harbour Service, the Chamber of Commerce, the Port Authorities of the various towns concerned, Dirkzwagers' Shipping Agency, the Management of Rotterdam Telephone District, Smit and Co's International Shipping Service, the Technical Department of B.P.M., one of the larger shipping lines, and one of the larger shipyards. A member of the National Committee on Radio Aids to Navigation also served in an advisory capacity. The Netherlands Experimental Radar Station at Noordwijk aan Zee was entrusted with the important task of working out details of the National Committee's scheme.

The Radar Committee adopted the advice of the National Committee, but only after they had investigated the merits of other systems and heard the opinion of experts. Subsequently an order for the manufacture of the harbour radar equipment was placed with N.V. Philips' Telecommunicatie Industrie at Hilversum.

Signalling Station at Hook of Holland.




The radar protection system of the New Waterway, which links Rotterdam with the North Sea. The sectors covered by the seven stations overlap.

## *Radar on the New Waterway, Holland—continued*

Two indicator units at the Hook of Holland Station.

**Why Not Ship Radar?**

It is generally believed that about one-third of the world's seagoing merchant vessels of over 3,000 tons are at present equipped with ship radar. In the light of this fact it might be asked why it is necessary to instal harbour radar in the circumstances. It should be remembered, however, that radar must always be considered as an aid to navigation. In courts of inquiry into accidents to shipping, both abroad and in the Netherlands, authorities have frequently pointed out that ship radar is no safeguard against irresponsible navigation. This applies to open water, but even more care must be exercised when the ship has to be piloted into the narrow entrance to a harbour and then over a fairly long and narrow route to the port of destination, as is the case with Rotterdam. If under such circumstances, visibility were bad owing to fog or other causes, it would be a sign of irresponsible seamanship to trust exclusively to ship radar.

**Harbour Radar.**

The following are some of the advantages of harbour radar over ship radar:

1. Harbour radar can be designed specifically for the piloting of ships into harbour (during fog or when visibility is bad). There is much greater scope for designing the installation, because the available space in a land station is greater than on a ship. The most important parts of the harbour radar installation can be provided in duplicate. Every available electronic and mechanical aid can be applied in order to obtain the sharpest and largest possible image of the area to be covered, so that the position of the ship concerned can be determined as accurately as possible.
2. The site on which harbour radar is installed can be selected so as to give the most favourable results. This is very important for when the site is well chosen no blind spots are caused by obstacles such as high buildings.
3. The operators of harbour radar equipment are completely familiar with local conditions along the route to be followed by ships. They are therefore in a better position at any moment to analyse the traffic situation than a ship's radar operator.
4. Unlike ship radar, harbour radar provides a completely motionless picture.
5. The indicator used with harbour radar equipment has a larger panoramic display and gives a more detailed picture.

The purpose of harbour or shore radar is to obtain a view of a certain part of a harbour or waterway from the shore when the captain of an incoming ship is prevented by fog, falling snow or hailstorms, etc., from seeing his surroundings. A port equipped with harbour radar can be an immense asset to the pilot, for even if he is perfectly familiar with the obstacles in the area and the depth of waters in which he is operating, he can receive invaluable assistance from the magic eye of radar when weather conditions are such that the human eye is unable to observe the surroundings.

Although the responsibility for the course to be followed rests exclusively with the captain and although the pilot has only an advisory function, the captain's task of docking his ship safely becomes easier in proportion to the extent of the pilot's knowledge and the excellence of his equipment. It is in no way the purpose of harbour radar to talk the ship in from the shore as is the case with the blind-landing installations for aircraft. The pilot of an aircraft who wishes to bring his plane down safely through fog has to rely more or less on the traffic control officer in the tower. It is often imperative to do so for he may be running short of petrol or he may have to keep to a strict time schedule. If necessary, a ship may wait outside a port or postpone its departure if the captain does not consider it safe to enter or leave. When he is on the river, however, he may come under the same compulsion as the air pilot if a sudden ground fog appears and reduces visibility to zero. These are the conditions in which harbour radar can show its worth.

**The Enemy of Shipping: Fog.**

What actually is fog? It has been internationally defined by meteorologists as the condensation of vapour causing visibility to be reduced to less than 1,000 m. It can, however, happen that when the sky is cloudless a shallow of fog forms over the water, making it impossible for the navigator on the bridge to find his bearings. It is true that this limitation only applies in the horizontal plane and not in the vertical. Fog can appear in an unlimited number of variations. In the relatively narrow and winding channel which is the main access to the Rotterdam docks, fog and bad visibility due to rain, snow and hailstorms may cause serious hold-ups, the cost of which cannot be accurately estimated but may nevertheless amount to an appallingly high total.

Along the coast of Holland an average of 240 fog hours occur every year. This represents a great loss of money and time. Who

Harbour radar display seen at Maassluis Station.

## *Radar on the New Waterway, Holland—continued*

Radar Tower at the Pernis Station.

are the people on whom this burden falls? One need only read the names of the members of the Nieuwe Waterweg Radar Committee to gain some idea of the enterprises which will benefit most from the installation of radar beacons along this waterway.

**The Harbour Radar Project for the Nieuwe Waterweg.**

To give a reliable picture of the traffic and possible obstacles in this tortuous waterway 7 radar stations have been projected, viz. No. 1 at Hook of Holland, No. 2 on the island of Rozenburg, No. 3 at Maassluis, No. 4 at the first Petroleum Docks, No. 5 at Pernis and Nos. 6 and 7 in the heart of the port near the Lek Docks and the Parkkade.

In each radar station a certain section of the river is indicated on two screens which can be set to a range between 2,000 and 5,000 metres (2,200 and 5,470 yards). Each screen shows approximately half of the area scanned by the station. If for any reason one of the screens fails, the other can be adjusted to a greater range, so that the sector originally covered by the two screens appears on a smaller scale on one of them.

At the Hook of Holland station there are four display units. This ensures radar coverage under all conditions not only of the stretch of river in the immediate vicincity, but also of the approach to the harbour entrance and the sea area beyond it.

The radio-telephone sets used by the pilots aboard the ships operate on 12 channels in the 160 mc/s band. Each of the seven stations has a different transmitting and receiving frequency so that they cannot possibly interfere with each other. An additional channel is available for the Hook of Holland and Rotterdam stations; three channels are kept in reserve. Each station is connected by a private telephone line to the nearest other stations and to the central bureau of the pilotage service at Rotterdam.

Aid for incoming ships begins several miles outside the entrance. If the pilot of a ship asks the Hook of Holland station for assistance, he is given the necessary information regarding his position and on this he bases his navigation. The sectors covered by the various radar stations overlap, so that for a brief period the ship is observed by two stations. When the ship reaches the limit of the range of the Hook of Holland station the next station is warned via the private telephone line. As soon as the echo is picked up there the pilot is told to switch over to channel 2 of the radio-telephone, whereupon the second station takes over the assistance. In this way the ship is guided successively through all the sectors scanned by the various radar stations.

For outgoing vessels the procedure is reversed.

The radar installations on the New Waterway are not intended solely for the benefit of through traffic; they are also at the disposal of the many ferry services. The ferry boats are equipped with radio-telephone sets so that they can maintain regular contact with the nearest radar station. When they are crossing the waterway in thick fog they can always be warned in good time of the approach of ships.

The shore radar stations are also of great importance for the activities of the various port services, which suffer far less inconvenience from stoppages when shipping is able to carry on normally during periods of fog.

The radar equipment housed at the 7 stations consists mainly of three sections: a radar antenna, a radar transmitter-receiver and an indicator. The two latter sections are provided in duplicate to permit an immediate change-over to spare equipment when a technical fault develops, for naturally no chances can be taken.

The radar transmitter-receiver operates in the 3 cm. band. The frequency of the transmitter may be adjusted between 8900 and 9200 Mc/s.

One of the most important components of the radar indicator is the cathode-ray tube. This tube, which has a diameter of 38 cm., gives a radar representation of the area covered by a particular station. This indicator incorporates a device which makes it possible to project three luminous lines on the screen by electronic means; these luminous lines may be adjusted with great accuracy. Navigation in a narrow channel in good visibility is made possible by means of leading lines. Leading lines are formed by setting up two fixed beacons on shore, and are especially valuable in bends. When the captain of a ship manoeuvres his vessel into a position from which he can see the two beacons (lights) in line, he knows that his ship is in the middle of the channel.

These leading lines are indicated on all maps. Since they are pictured electronically as luminous lines on the radar screen, the operator in the radar tower can give the correct course to the pilot.

As the luminous electronic line is a broken line—each section representing an actual length of 100 m.—the distance between the ship and the line of lights can be easily estimated.

By means of the bearing line the radar operator can quickly determine the ship's bearing from a certain point. The distance of a ship to this point is measured by means of an electronic range marker that may be shifted along the bearing line. The origin of the bearing line need not necessarily coincide with the position of the station.

**Conclusion.**

When the complete installation is in full working the Port of Rotterdam will be the first in the world which can safely navigate ships to the docks by means of a chain of harbour radar stations when bad visibility makes normal navigation impossible. That this project will mean great financial economies will be easily understood. It should not, however, be expected that shipping traffic will be completely unaffected by foggy weather. Even with harbour radar in operation fog will still cause delays, but on a considerably smaller scale than now, and only the thickest of fogs will bring shipping traffic to a complete standstill. Harbour radar will not only ensure greater regularity in the movement of ships and in work in the docks but also greater punctuality for the thousands in the Rotterdam area who have to cross the water by ferry to reach their work.

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**Institute of Materials Handling.**

The Fourth Annual Dinner of the Institute of Materials Handling took place on the 14th November, 1956, at the Trocadero Restaurant, London, and was attended by over 250 people. The importance of materials handling as a means to speeding production and improving Britain's general economy is evinced by the growing membership of the Institute.

The Rt. Hon. Harold Wilson, O.B.E., M.P., provided the main speech of the evening and Mr. C. Kenneth Horne, Chairman and Joint Managing Director of the Chad Valley Company, Limited, replied to the toast of the guests. Other speakers included Mr. John R. Sharp, Chairman of the Institute of Materials Handling, and Mr. Gavin C. Paterson, a founder member of the Institute.

# Marine Pilotage

## History, Development and Service

*(Specially Contributed)*

*(Continued from page 220)*

**Methods of Recruitment.**

The requirements relating to age, qualifications and examination of candidates for a pilot's licence are set out in Byelaws drawn up by the Local Pilotage Authority and, apart from a general insistence on British Nationality and a high standard of medical fitness, there is no moral code which is common to all Districts. The London Trinity House for most licences require a Foreign Going Master Mariner's Certificate, and a candidate must be "called" before attaining the age of 35. In addition, he is expected to have had, or will be required to obtain practical experience of navigating vessels in the waters or District for which he seeks to be licensed. On entry, a pilot is limited to a certain draught or tonnage and several years may elapse before he graduates to a pilot of the highest class and becomes qualified to pilot vessels of any tonnage. When on duty, their London Trinity House pilots wear a prescribed uniform and with their long tradition and careful selection, they form what might be described as the pilotage corps élite. The London District covers a wide area and takes in several ports and a number of navigable channels, a situation which is met by subdividing the District for purposes of licensing and administration.

For the River Mersey, the Mersey Docks and Harbour Board is also the Pilotage Authority for the District. Pilotage is compulsory for vessels bound inward from Point Lynas on the north coast of Wales, but for vessels outward bound pilotage ceases to be compulsory at the Bar Light vessel, a distance of about sixteen miles from Liverpool. Foreign vessels find this a somewhat confusing rule. Exemption from compulsory pilotage is granted to certain classes of vessels. The 170 pilots at Liverpool, in addition to navigating the channels, also conduct vessels into or out of the numerous lock entrances which give access to the impounded waters of the Liverpool and Birkenhead dock systems. Vessels bound for the Manchester Ship Canal or the new Queen Elizabeth Oil Dock also remain in charge of a Liverpool pilot until secured in the lock at Eastham. These pilots commence as boat hands at the age of about sixteen in one of four pilot vessels—a period of four years apprenticeship follows although the boys are not formally bound by signed indentures. The boat hand may be required to go to sea in order to obtain a Ministry of Transport Certificate as 2nd Mate or he may pass out as a junior Pilot as vacancies occur. Pilotage within the docks is not compulsory and is carried out by the sea pilots.

The Manchester Ship Canal Company as Pilotage Authority license about 64 pilots for the Canal. These men are required to have had four years' experience as helmsmen or apprentice on the Canal. The helmsmen are recruited from men holding a 2nd Mate's F.G. Certificate. The helmsmen usually embarks with the pilot and steers the vessel under his direction. Service as a helmsman has in the past sometimes extended to 11 years but the more recent situation is that few, if any, of the present helmsmen have been long enough on the job to qualify under existing rules for a pilot's licence.

The navigation of the Canal calls for unremitting vigilance from the helmsmen and both from the point of view of training pilots and also the safe navigation of the vessel the system of employing a local helmsman to assist the pilot has much to commend it. Pilotage is, however, non-compulsory in the Manchester Ship Canal.

Swansea, a non-compulsory District (except for vessels carrying passengers) follows the Trinity House pattern and has no apprenticeship system. Officers with a Foreign Going Master's Certificate are entered between the age of 28 and 35 as Probationers.

The other large Districts in the Bristol Channel—Bristol, Cardiff, Newport and Barry all have an apprenticeship system. Boys are entered at the age of 15 or 16 and serve four, in some cases five years in the Pilot Vessel, after which they obtain employment in the Merchant Navy until a vacancy occurs in the pilot service, by which time they must have obtained a 1st Mate's F.G. Certificate (for Bristol) or a Master F.G. (Cardiff and Barry), whilst Newport also now calls for a 1st Mate's F.G. Certificate.

The East Coast Districts—Tyne, Tees, Sunderland and the Humber—adopt a form of apprenticeship usually lasting about five or six years, some of which may be served in the Merchant Navy. Some portion of this time is devoted to accompanying pilots engaged on acts of pilotage — not as assistants but as pupils or observers. The emphasis in the East Coast Districts is on the possession of local knowledge, and qualifications such as Master or Mate are not regarded as essential.

The Clyde sets a fairly high standard in recruiting from officers holding a Master's F.G. Certificate who have held command or who have served as Chief Officer.

The total number of pilotage apprentices in the whole of the United Kingdom probably does not exceed 180—but in one form or another the system is responsible for supplying candidates for all the vacancies which occur in Liverpool, Manchester, Bristol, Tyne, Tees, Humber, Cardiff and Barry.

The employment of apprentices, when there exists direct recruitment from the Merchant Navy, has been criticised as a form of cheap labour with the element of a "closed shop" designed to limit the supply in order to keep the market value of a pilot high. Some Authorities reserve the right to waive the apprenticeship qualification under certain circumstances. The experience gained during the formative years of a man's life does nevertheless provide a basis which subsequent service at sea broadens into a high degree of competence for service as a pilot.

Age of entry as a pilot varies widely. In the Humber the age is between 23 and 35, but in Bristol, Cardiff, Manchester and the Tyne a pilot may receive his first licence up to the age of 45, whilst for Newport the age is as high as 50. The tendency to-day is for pilots to be licensed at an early age, and providing a man has developed a sense of responsibilty (which service at sea quickly does) a young pilot soon becomes a veteran at his job.

The official view regarding qualifications seems to be that the possession of a Home Trade Master's Certificate or a First Mate's Foreign Going Certificate is the appropriate standard for a candidate for a pilot's licence and whilst the ability to pass the Ministry examinations is not the sole criterion of a man's skill to perform a practical job such as piloting a ship, it is somewhat surprising—having regard to the general uplift which has taken place in intellectual standards, that such a comparatively modest level finds acceptance for this important service. It might be supposed that some uniform standard of qualification would exist in those Districts in which pilotage is compulsory, but the absence of any guiding principle, apart from tradition, in determining why a District is compulsory reveals to some extent the depth at which the roots of these anomalies may be found.

There is, however, a growing appreciation that the qualifications should keep pace with the conditions and standards of knowledge prevailing in the shipping industry. The opposite tendency—to be satisfied with a lower qualification, if suitably qualified men are not available from the ranks of ex-apprentices, is a somewhat imprudent form of juggling with supply and demand, which may reduce the security of the service to the shipowner and provides a shaky foundation to the "status" which the pilot seeks to establish for his profession.

Retirement can usually be looked forward to at 65, but several Authorities are rather vague on the subject and pilots of more than 70 years of age continue to be licensed. Having regard to the high level of earnings of a senior pilot, the pensions are meagre. However, provision for old age can readily be arranged by the individual who is prepared to set aside an adequate sum from earnings.

Pilots are probably conscious that an insistence on the possession of a Foreign Going Master's Certificate would help to justify their claim for earnings of not less than those of the ship master of the vessel they are called on to pilot—or of what is now termed "a representative ship." The contention of the Chamber of Shipping is that a pilot should receive a reward somewhere between the pay of a Master and the First Officer of such a ship.

Basically, the pilotage is a highly specialised skill in local navi-

## *Marine Pilotage—continued*

gation which can be learnt by training and experience. It appears therefore that, in a service which is rendered to ships of all nations, some uniformity in what might be termed the background qualification of the men who render these services would be advantageous to the pilots, the shipowners and the negotiating machinery.

**Deep Sea Certificates.**

From early times the Trinity Houses of Leith, of London and Newcastle exercised the power to grant certificates to pilots for large areas of the seas which were not within the Pilotage District. For example, Leith claimed the right to grant certificates for piloting vessels "along the entire coast of Scotland and along the coasts and islands of the Northern and German oceans." Under the Forth Pilotage Order, 1947, the Trinity House of Leith ceased to be the controlling Authority for the grant of licences and certificates, but the power to grant deep sea certificates continues to be exercised by the newly constituted Forth Pilotage Authority. A similar power at one time held by Trinity House of Newcastle has been taken over by the Tyne Pilotage Authority, on which body the Trinity House of Newcastle are represented. Of the Trinity Houses of earlier times, that of London continues with its powers unimpaired. The Clyde Pilotage Authority also possesses this power.

The practice of granting such certificates led to confusion owing to considerable overlapping which, having regard to the rather flimsy character of the jurisdiction which a Pilotage Authority might exercise beyond its Statutory District, would seem to be an inevitable consequence. The certificate is now granted merely as a "certificate of competency" by a Pilotage Authority with appropriate powers and exercising jurisdiction over the Pilotage District which is contiguous with the deep sea zone.

The certificate has a high reputation, but the limited powers of the certificating body give no authority to the holder of a deep sea certificate to supersede any person whether certificated or not, who may already be piloting a vessel outside a Pilotage District. This limitation and the Authority's lack of power to determine a scale of charges are in contrast to their powers within their own District.

With the detailed large scale charts which are available and a careful study of the tidal streams which are shown on the charts and described in the sailing directions, the navigation of the waters in which the deep sea pilots operate is well within the cauabilities of a competent navigator. During the war years, the traffic lanes of the North Sea were kept free by minesweepers and escort vessels, many of which were commanded by R.N.V.R. officers (not professional seamen). War casualties were heavy but the number of marine casualties due to faulty navigation were remarkably few, and this at a time when many sea marks had been withdrawn and vessels often navigated on wreck buoys.

The introduction of radar as an aid to navigation has provided the coastal navigator with an instrument which may encourage him to proceed unaided by the deep sea pilot, whilst there are several shipping companies who employ a staff of relieving masters, whose knowledge of coastal navigation may well compete with that of the deep sea pilot.

The service provided by certificated deep sea pilots can however give a welcome relief to a deep sea shipmaster when coasting from Dungeness up the North Sea and around the coast of Scotland, or through the treacherous shoals of the Goodwin Sands and the near Continental coasts.

**Status of a Pilot.**

The exact status of a pilot is somewhat difficult to define. The type of relationship contemplated between pilots and the Authority is indicated by the powers conferred on the Authority—to make byelaws as to certain specified matters such as (1) qualifications, age, physical fitness, length of service, local knowledge, skill, period for which licence is in force and conditions for renewal; (2) deciding the number of pilots to be licensed and the method of filling the vacancies; (3) providing generally for the good government of pilots and apprentices and ensuring their good conduct and proper attendance and performance of their duties whether afloat or ashore. Even so, it is clear that the full relationship of master and servant does not exist between the Pilotage Authority and a licensed pilot. The liability of the Authority for any loss occasioned by the default of a pilot in the performance of his duties is expressly negatived by section S. 19 of the Pilotage Act of 1913.

For the purpose of the National Health Act a pilot is a "self-employed" person, although it might be held that he is intermittently employed by the master of the vessel he pilots. By the Admiralty a pilot has sometimes been considered to be a member of the crew of the ship under pilctage.

The provisions of the Finance Act 1956, making tax concessions to self employed persons on insurance premiums for pensions, would hardly seem to apply to pilots who, although self-employed, are usually beneficiaries under a "sponsored" pension scheme.

The feeling of independence which a self-employed person may have enjoyed has lost much of its flavour in the case of a pilot. A Pilotage Service requires to be organised so that the work is fairly distributed, a rota of duties or turns is essential for ensuring that pilots are available at the right time and place—in many Districts the pilotage dues are pooled into a Common Fund, a system which can only be operated by some form of central control and administration. In most Districts a pilot's job is a full time occupation and the element of independence, which the nature of their work gave pilots when they operated individually—each pilot owning his own boat—is fast disappearing. This almost traditional independence has been a serious fetter on enterprise and concerted action in the field of negotiations.

The United Kingdom Pilots Association, which was formed more than 70 years ago to look after the interests and conditions of service of its pilot members, has had a very considerable measure of success. Founded at a time when major reforms were taking place in the shipping industry, the views which the Association were able to put forward made a valuable contribution to the drafting of the Merchant Shipping Act, 1889, and later the consolidating Merchant Shipping Act, 1894, and finally the Pilotage Act, 1913.

For more than 40 years under the able and persevering secretaryship of Sir John Inskip, the Association has struggled to coordinate the widely different views of its members in order to produce a strong, well-considered and united policy. Several groups of pilots have broken away from the Association and to-day, out of a total of about 2,000 pilots, the Association represents probably less than half this number. To a comparatively small group of men the numbers and powers of the great Unions may appeal as a stronger platform from which to urge their claims. The Transport and General Workers Union represents the other half.

Negotiations and discussions have been going on for many years between shipowners and pilots' organisations, with a view to determining a formula for a pilot's remuneration, which would be acceptable throughout the country. The Shipowners "sea service comparison" is regarded by the pilots as unrealistic—in their view they are specialists in pilotage and their true value as such ought to be separately assessed—although they seem inclined to agree that their remuneration should be not less than the master of "a representative ship." Unfortunately, although the recent negotiations were supported by a common and united front among the pilots, for the first time since many of them broke away from the U.K.P.A. years ago, no firm settlement has been achieved.

The Pilotage Rates which bring in the revenue for pilots' earnings are fixed by the Minister of Transport and Civil Aviation on proposals put forward by a Pilotage Authority. If the pilots feel aggrieved by a decision, they may appeal and the Minister is empowered to appoint an independent Arbitrator to preside over a Public Inquiry. The first Inquiry of this kind to take place since the war was held at Manchester in June, 1956; the results are not yet available but presumably the Arbitrator's Findings are submitted to the Minister who once again makes the final decision. It would appear that the procedure which finally leads to the Industrial Disputes Tribunal is not available to a licensed pilot.

The pilot's position on board in relation to the Master has been the subject of endless discussion. The simple truth is that in British ports and in most foreign ports the Master never relinquishes the responsibility for the safety of his ship. Charts of most ports are

## *Marine Pilotage—continued*

available and if the Master arranges for his Navigating Officer to keep a close plot on his vessel's course and position, whilst being piloted, it can only be regarded as a prudent policy to safeguard his own position.

Prior to Nasser's take-over, the Suez Canal pilots were employees of the Suez Canal Company and a situation more properly that of master and servant existed. The Company set out the terms under which their pilots were employed and as they are a good general description of the practice which prevails in United Kingdom ports and Pilotage Districts, they are quoted in full.

> " Pilots only give advice on manoeuvring the ship. They place at the disposal of captains their experience and practical knowledge of the Canal but they cannot be acquainted with the defects and peculiarities of individual ships whether in navigating, stopping, starting, etc., the responsibility of handling the ship devolves solely upon the captain. It is therefore for the captain, taking into account the indications given by the pilots to give the necessary orders to the helm, to the engines and to the tugs. If, in the interest of rapid manoeuvring, the captain thinks it preferable to allow the pilot to give orders direct, manoeuvres carried out in these circumstances shall be considered as having been carried out on the orders of the captain and engage his sole responsibility."

**Pilotage Districts.**

The word " district " does not seem to fit into the nomenclature of the sea. It is, however, an apt choice for the purpose of describing a definite area over which jurisdiction is exercised. The navigable waters of the globe may be classified under three heads, internal waters, territorial waters and the " high seas." Other states may have very different ideas about the width of the " territorial belt " but the traditional British policy has been to regard the 3 mile limit as that over which Britain exercises sovereignty. The application of British Statutes is therefore confined to internal and territorial waters and a Pilotage Authority operating under the Pilotage Act 1913, when determining the limits of its District has no power to extend it beyond the territorial sea. It is for this reason that the deep sea Certificates, which some Pilotage Authorities have power to grant, are merely " certificates of competency."

The coastal waters of Great Britain are divided into Pilotage Districts and each district is carefully defined in a Pilotage Order. Some Districts do not extend much beyond the port itself. For example, the Tees Pilotage District includes the River and docks etc., and the waters of the sea within one mile of the mouth of the River Tees. The Customs port and the Pilotage District coincide in some ports. In the Bristol Channel, however, an unusual situation arises—the Bristol District includes the waters of the Bristol Channel to the east of a line joining Hartland Point to S. Lundy Island and across to Caldy Island on the Welsh coast. Lundy is about 70 miles from Bristol. The validity of this jurisdiction would seem to be open to question in view of the Foreign Office ruling made in 1927 that a position 10 miles south of the Welsh coast and about 8 miles north of Ilfracombe was not within the territorial sovereignty of His Majesty. A more realistic assessment of the jurisdiction of the British Crown was made by the Trinity Masters in 1604 when the boundaries of the Kings Chambers were determined and the waters east of a line joining Lands End to Milford Haven were declared to be within the King's Chambers and thus within the municipal law of the Realm of England.

In deciding the limits of a Pilotage District careful thought was given to the particular positions where ships begin to require the services of a pilot. These limits, which are found only from experience, should include those places where a pilot can be most easily taken aboard under all conditions of weather. Complications sometimes arise when the compulsory line for vessels carrying passengers differs from that for other types of vessels.

The cost of maintaining cruising cutters at the seaward limit of a District has in some places forced the pilots to retreat to a position much nearer to the port, in order to keep costs down. There have been few changes in the boundaries of Pilotage Districts since they were first defined more than 30 years ago. A present day assessment would have to consider, among other things, the almost complete disappearance of the sailing ship, the great increase in the speed of ships, the improvement in large scale charts, and finally, the introduction of echo sounding and radar, which now make it possible for a vessel to arrive close off the entrance to a port without the aid of a pilot.

*(To be continued)*

# Fumigation of Ships, Barges & Warehouses

## Versatility of Methyl Bromide

*(Specially Contributed)*

The economic considerations of disinfestation practice in barges, ships and dock warehouses has already been discussed in previous issues of this Journal. The outstanding reasons for pest control are, of course, that very considerable losses of foodstuffs and damage to fabric and other vegetable materials occur during their transport and storage and that human foodstuffs very quickly become unwholesome with the droppings and bodies of countless insects, mites and rodents. The point cannot be stressed too often, however, that when the disinfestation problem is viewed as a whole, the treatment of **isolated** consignments of goods is inefficient. For instance, although it may seem unnecessary to cleanse cereal offal which is to be processed into animal feeding stuffs this material is a source of infestation of human foodstuff since residues, however small, in the transport or storage equipment are potential transmitters of infestation.

It seems then that very comprehensive and thorough methods are required to preserve dock hygiene and the question is one of choosing the most suitable means. In the handling of bulk cargoes it is inevitable that some residues will remain lodged in crevices which are inaccessible to liquid cleansers so the only effective way of reaching them is by fumigation. For many years hydrogen cyanide has been considered a satisfactory fumigant for this work. Recently, however, investigation of alternative gases has focussed attention on methyl bromide which has certain advantages for ship fumigation, from the point of view of its penetrative powers, and in the treatment of foodstuffs and other commodities ashore.

Methyl Bromide fumes being blown over a barge by a mobile unit.

Methyl bromide is relatively inert chemically and is subject to low sorption physically. It does not form poisonous residual compounds with the sugars of dried fruits—an unfavourable property of hydrogen cyanide—and it has been demonstrated that, when necessary, cheese, butter and dehydrated milk can be successfully fumigated and there is no evidence that this reduces the nutritive value. The low physical sorption means that the gas has remarkable powers of penetration; it is not hampered by sacks, boxes, bags, bales, wooden or fibreboard cases or large masses of

## *Fumigation of Ships, Barges and Warehouses—continued*

bulk material. The furthest sites of pest habitation are reached by methyl bromide; the gas is practically insoluble in water which means that the effective concentration of the gas is not reduced in wet or damp holds or premises as occurs when the highly soluble hydrogen cyanide is used; furthermore, dissolved gas which is slowly released can be a considerable hazard after fumigation.

The same property is rapid penetration is of value in swift clearance of methyl bromide in the post fumigation ventilation period. Since the gas is 3¼ times as dense as air it tends, initially, to settle when large spaces are under treatment; ½-hour spells of circulation by small fans at the beginning of fumigation will, however, ensure efficient distribution of effective concentrations.

Methyl bromide has been described as the most versatile fumigant—an attribute particularly true of its toxicity. The gas is lethal to almost every insect pest at any stage of development, whether egg, grub or adult, as well as to rats and mice.

Most of the susceptible goods handled at ports can be successfully disinfested with this fumigant; these include cereals and cereal products, dried fruits, dairy products, herbs, spices, tobacco, fabrics and fibres. Various forms of living plant material and seeds can be subjected to treatment during quarantine without harmful effect. Timber in the form of sawn softwood and some hardwoods can be disinfested even when close packed in ships' holds.

Methyl bromide is, of course, also toxic to man—as little as 17 parts per million in air is considered to be the safe limit for prolonged human exposure. The precautionary measures which should be taken in use for fumigation are dealt with in a Home Office Bulletin " Fumigation with Methyl Bromide—Precautionary Measures," published by H.M. Stationery Office (price 4d.).

Rubberised Sheeting being laid over stacks prior to fumigation.

Because of the toxicity of methyl bromide, it is obvious that fumigation must be done under gas-tight conditions; this is, incidentally, also necessary to build up effective concentrations. The preparations for treatment and the actual operations are therefore best left in the hands of expert fumigation companies.

# The St. Lawrence Seaway Project

## Raising of the Jacques Cartier Bridge

Some details have now become available of the method by which the Jacques Cartier Bridge is to be raised to its new elevation over the St. Lawrence Seaway in order to provide a minimum headway for shipping of 120-ft. Some fourteen spans of the bridge, between 125-ft. and 250-ft. in length, and weighing about 14,000 tons, are to be raised through varying vertical distances of up to 60-ft., without necessitating any interruption to road traffic.

The earthwork for the Seaway channel has now been completed at this site. It will be seen from the view of the approach spans, reproduced here, that the final position, shown superimposed in white outline, entails very considerable heightening of the concrete piers and that the central existing 250-ft. deck-type span is to be replaced by a through-truss span.

The lifting work is to be carried out by large-capacity hydraulic jacks capable of operating over a very wide temperature range. The jacks are double-acting and designed with mechanical stops to hold the ram at any position if the hydraulic pressure is released. They will be operated in nests of four, each nest being driven by a motor-driven pump sited on top of the bridge pier. Control of the rams will be by hand-operated lever control valves grouped in pairs. It is planned to raise the spans 6-in. at a time and to support the bridge temporarily on concrete blocks. At each 2-ft. of lift, concrete courses will be poured around the blocks, so raising the pier elevations by stages to their required heights.

The work is being carried out under the supervision of Dr. P. L. Pratley who originally designed the bridge in 1929. The hydraulic lifting gear, estimated to cost 150,000 dollars, is to be provided by Tangyes of Canada Ltd. and will be manufactured in England.

## New Timber Carrying Railway Wagon

Arising from investigations carried out by the North Eastern Region of British Railways in connection with the despatch of timber from tenancies, it became apparent that with the increasing use of mechanical handling appliances, the normal method of loading in ordinary open rail wagons, with the timber " tailing " over one end, has a disadvantage in that wagons so loaded cannot readily be discharged by fork-lift truck, quite apart from the fact that the quantity of timber which can be accommodated under such conditions is considerably below the carrying capacity of the wagon.

Following informal discussions with local timber trade organisations, it was considered that a modified wagon, as described below, would be generally acceptable to the trade and particularly to those firms who have mechansed their storage grounds.

The basis of the new rail wagon is a four-wheeled chassis with a wheelbase of 15-ft. Other leading dimensions are as follows:—

| | |
|---|---|
| Inside length ... ... ... | 27-ft. 0-in. |
| Width inside side stanchions ... | 7-ft. 5½-in. |
| Height of ends ... ... ... | 6-ft. 1-in. |
| Height of side stanchions ... | 5-ft. 10-in. |

The side stanchions, of which there are seven on each side, are detachable and in addition, provision is made for three removable centre stanchions. Five bolsters are fitted crosswise in the usual manner and the vehicle is capable of carrying 4/5 standards of timber.

Brief details of the new wagon were given by Mr. J. A. R. Horsley, Head of Freight Development Section, Chief Commercial Manager's Office, British Railways, North Eastern Region, York, at the Timber Handling Conference held in Manchester recently and the consensus of opinion was that a wagon of the type described is something which the trade has been wanting for some time.

# Hydraulics Research Station at Wallingford

## Review of Work in Progress

FOR the first time since its opening in 1952, the Hydraulics Research Station of the Department of Scientific and Industrial Research, Wallingford, was opened to the Press on 31st October last. Although the Station is not yet completed, some eight models and supplementary instruments and machinery were on display.

The work of the Station is, for the most part, concerned with loose-boundary hydraulics, which means problems arising as a result of currents or wave action causing erosion and silting of the banks and beds of rivers, estuaries and the sea coast. Eighty years ago in England Osborne Reynolds and, later, Vernon Harcourt were pioneers in the use of hydraulic models; then came a gap. In the late 20's and early 30's of this century, Professor A. H. Gibson carried out with the aid of models his outstanding investigation into the Severn Barrage Scheme. Until recently, however, there has been no continuity in Hydraulic Research in this country, whereas, first in Germany and later in India, Holland, France and the U.S.A. very large stations have developed during the past 30 years.

Sir Claude Inglis, Director of the Hydraulics Research Station emphasised to the Press that it is a common fallacy that all that is necessary to solve a hydraulic problem is to construct a model and it will give all the answers. This bears little resemblance to the facts. At least in the present state of our knowledge, models of rivers and coasts with fluctuating conditions are merely an important aid, not the answer to the solution of complex hydraulic problems. Though models give essential data about currents and tides, which cannot be obtained satisfactorily in any other way, they give only a small part of the information required to solve loose-boundary problems, so that sound conclusions can only be arrived at by careful diagnosis combined with wide experience of the changes which occur in nature and the corresponding, but limited and often different changes which develop in the models.

Of the eight models at present under observation at the Station, three of these are for overseas authorities, Tema Harbour in the Gold Coast, Karnafuli River in East Pakistan and the Navet Dam Spillway in Trinidad.

**Tema Harbour Model.**

The new harbour which is now under construction at Tema, some 20 miles east of Accra, in the Gold Coast, was designed by a British consulting firm who submitted their design to the Station for testing by means of a model. This model reproduces a stretch of coast 13,000 feet long and extends the equivalent of about 7,000 feet out to sea. Accuracy in the reproduction of the bed is particularly important in wave-disturbance models and in the Tema model levelling is thought to be accurate to within $\pm 1/10$ inch while accuracy in plan is to within $\pm \frac{1}{4}$ inch.

The basin in which the model has been built is equipped with means of producing storm waves coming from any of the directions from which these waves are known to come. The wave generator can produce waves of any required height and of the equivalent of any period between 7 and 45 seconds. The effectiveness of the harbour in protecting ships against storm waves was determined by comparing the heights of waves outside and inside the harbour; the wave heights were recorded automatically by means of electrical resistance gauges. For waves longer than storm waves another machine called a surge generator is used, capable of generating waves of any period between 40 seconds and 5 minutes. Such waves in nature are usually very low, seldom more than a few inches in height, and they cannot be detected by eye. Nevertheless they can cause quite large horizontal movement of ships.

The first stage of the investigation was concerned with the entrance to the main harbour. The Station was able to show that the outer breakwater could be 500-ft. shorter than proposed without impairing the efficiency of the harbour. As the cost of the breakwater at this point is between £200 and £300 per foot this will result in a considerable saving. In the second stage of the investigation nine different designs of the entrance to the small fishing harbour were examined. The design that was finally accepted had many advantages compared with that originally proposed but as the entrance is to be situated at a depth where the waves break it is impossible to design an entirely satisfactory entrance for that position.

**Model Study of the Karnafuli River, East Pakistan.**

The Karnafuli River flows into the north-eastern corner of the Bay of Bengal. Some ten miles from the sea on the right bank of the river lies the Port of Chittagong, which, since partition from India in 1947, has been and is being developed as the major port for East Pakistan. This model study is aimed at solving problems which have arisen at the Port and in the adjacent river approaches. The investigation is being carried out for the Government of Pakistan under the Technical Co-operation Scheme of the Colombo Plan.

The problems are to establish and maintain a channel of adequate depth alongside the new Port jetties by suitable river training, avoiding dredging; to stabilise the channel upstream of the Port which at present meanders and is the predominant factor in the instability of the jetty channel; and to establish and maintain adequate depths in all parts of the approaches to the Port from the sea.

In addition, the effects on the river and port of a substantial hydro-electric project now under construction forty miles upstream of Chittagong will be studied. The reservoir created by this scheme will reduce the freshwater floods, will trap the sediment carried down from the headwaters and will maintain a dry weather flow.

The Karnafuli is a typical monsoon fed river, its freshwater discharge ranging from a maximum in the wet season which may be as high as 250,000 cubic feet per second to a minimum in the dry season of 2,000 to 3,000 cubic feet per second. The highest tides have a range of 18-ft. at the entrance to the river.

The model at Wallingford represents some twenty miles of the Karnafuli and is being built in two stages. The first stage, already in operation, starts about ten miles upstream of Chittagong and finishes some three miles from the sea. This will be used to solve the problems of maintaining and stabilising the channel. The second stage, which will be built later, will extend to the sea and will include a stretch of coastal water about 5 miles long and 2 miles wide. It will be used to solve the problem of establishing and maintaining the approaches to the port from the sea.

In order to reproduce the channel movements observed in nature, the model is moulded in a material which can be moved by the action of water and it is operated under the appropriate scaled down hydraulic conditions of tides and freshwater flows. Tides are reproduced in the model by a new form of tide generator which utilises automatically controlled weirs.

Of the work in hand for the United Kingdom, three models are largely concerned with flood problems:

**Humber Wave Wall.**

The model represents a typical section of the embankment running along the right bank of the Humber for 15 miles northwards from Grimsby. This embankment was built up in haste after the floods of February 1953 to a height of 1.2 feet above the highest recorded level of tide. Now it is proposed to erect upon it a concrete wave wall that would provide security in the event of a similar storm tide coinciding with a period of wave action.

The embankment is constructed of an assortment of materials including broken concrete masses that render pile driving into the embankment impossible. Accordingly, the wave wall topping the embankment must be such that its stability is derived from its mass. The stability of such a structure in which wave forces are opposed by mass is a suitable subject for a quantitative model experiment. The experiment is also concerned with the height to which the wave

## *Hydraulics Research Station at Wallingford—continued*

wall should extend in order to prevent overtopping, and the best shape for the surface of the wall exposed to the waves.

The model reproduces a section of the embankment and beach extending 500 feet out to sea. The height and period of the waves that are likely to reach the structure have been calculated from assumed wind strengths and from the width of the Humber. These waves are reproduced to scale in the model. Several alternative designs have been tested.

**Tidal Trent Investigation.**

The tidal reaches of the River Trent, which extend from its outfall into the Humber at Trent Falls to Cromwell Lock a few miles downstream from Newark, lie in some of the richest agricultural land in England. Some 31,000 acres of land in the neighbourhood of Gainsborough were flooded in 1947 and smaller areas have been flooded more recently. Some of the land concerned is pasture land which suffers no harm from flood, but some of it is arable land which is harmed. The Trent River Board has under consideration a number of schemes for alleviating flooding in this part of the river and has asked the Station to examine these by means of a model.

The model reproduces the river channel and the land on either bank that is subject to flooding. Upland flow and tides are produced, the former by means of a pump and a metering device and the latter by a pneumatic tide generator. Water levels in the model are measured by an electrical gauge which gives indications to about 0.001-ft., or about one inch in the river.

The model has been proved, that is to say, the tidal levels and the rate of flood and ebb at six recording stations have been adjusted to correspond with actual levels by varying the bed and side roughness of the model river channel. Tests on alleviation schemes are now proceeding. These include provision of flood openings at bridges, construction of by-pass channels and barrages and the removal of constrictions.

**Shrewsbury Flood Relief Scheme.**

The River Severn starts to flood the town of Shrewsbury whenever the flow in the river exceeds 10,600 cubic feet per second (cusecs). In recent years flooding has occurred on the average once a year and there have been two serious floods. In February, 1946, during the highest flood since 1795, the estimated peak discharge was 18,000 cusecs, and this resulted in a water level some 6-ft. higher than the bank level. Severe flooding, causing damage to property and dislocation of traffic and communications was again experienced in March, 1947, when the flood peak rose to a level only 5-in. lower than that recorded the previous year.

With the object of reducing these excessive flood levels, a Flood Relief Scheme was prepared in 1948 by the Engineer to the Severn River Board. The Scheme included cleaning up the river channel from a point immediately upstream of Shrewsbury for a distance of about 9 miles downstream and removing an existing solid weir and replacing it by a battery of three semi-automatic sluice gates with small fixed side weirs. The total cost of the scheme was estimated at about £1 million.

A model study of this scheme was made with the following objectives: (a) to check the estimated reduction of flood levels in Shrewsbury; (b) to investigate the effects of the scheme on the unimproved river downstream and (c) to ascertain whether the proposed scheme might be modified to reduce its cost without impairing its efficiency.

Two models were constructed for the investigation. The first was a large-scale model of the four-mile stretch of the River Severn around Shrewsbury. This model, which was used mainly for objectives (a) and (c), has been demolished. The second is a smaller scale model reproducing about 24 miles of the river from Shelton, three miles above Shrewsbury, as far downstream as Buildwas at the head of the Ironbridge Gorge. This has been used for objectives (b) and (c).

The model reproduces both the channel of the river and the land on either side of the river. Surveys of the river by boat, aerial surveys and Ordnance Survey maps provided the information for moulding the model. Water levels in the model were measured by micrometer point gauges (reading to 0.001-ft.) mounted at points on the model corresponding to the positions of measuring points on the river. Discharges were measured on an instrument known as a Free-Running Rotary Flowmeter which was developed at the Station.

The first stage in the investigation was to prove the model, i.e. to verify that water levels observed in the river for different flows were correctly reproduced. Then the proposed improvements were incorporated into the model and the lowering of water level at each gauging station over a wide range of flows was determined.

As a result of these and other measurements made in the model the following conclusions were drawn: (1) the improvements envisaged in the scheme would reduce flood levels in Shrewsbury by about 2-ft.; (2) very nearly the same results would be gained if only three miles of the river immediately upstream of Shrewsbury Weir were improved. This would reduce the cost of the scheme; (3) the improvements would have little or no adverse effect on river levels downstream of the improved section.

The only model of a harbour in the British Isles being studied at present is one of Eyemouth harbour, although work is in hand on models for estimating the scouring and silting effects of tidal flow in Portsmouth harbour and the Mersey estuary.

**Eyemouth Harbour Model.**

Eyemouth harbour is situated in a rocky bay nine miles north of Berwick-on-Tweed. It is principally a fishing port. Recently about 50 fishing boats have used Eyemouth as their base. At certain times a ridge of sand known as a sandbar forms in the entrance channel leading to the harbour as a result of wave action. When the sandbar builds up the fishing boats can enter and leave the port only near high water and this is having a serious effect on the fishing trade. Several proposals have been put forward to remedy this situation, including a sluicing scheme in which tidal water impounded in Eye-Water at high tide would be released at low water to scour the entrance clear of sand by the impetus of its velocity. A design for a new harbour entrance, which might cost £250,000 has also been prepared.

The Station has been asked to find why the sandbar forms, to test the effectiveness of the various proposals suggested to prevent its formation and to advise on the most economical solution to the problem. The conditions leading to the formation and growth of the sandbar have been examined by survey teams from the Station working in Eyemouth Bay and much useful information has been obtained.

The model which has recently been constructed at the Station will be used to compare the various proposals for harbour improvement. Tides will be reproduced in the model by a tidal generation unit which has been specially designed for the investigation. Waves will be reproduced and for this a new form of pneumatic wave generator has been built. The bed of the bay and the beach in the model has been made of fine sand from Leighton Buzzard in Bedfordshire. Before the model is used for tests it must be satisfactorily proved and to do this use will be made of radioactive tracers in the form of soda glass particles activated at Harwell These tracers will show the movements of sand in the models. This is the first time they have been used in this way for hydraulic model experiments at the Station.

**Portsmouth Harbour Investigation.**

The Admiralty are considering the possibilities of reclaiming inter-tidal mud flats within Portsmouth harbour. The effect of such a reclamation will be to reduce the amount of water which flows in and out of the harbour as a result of the tides and this may affect the approach channels because they are maintained by the scouring effect of this tidal flow. Work on the investigation so far has been of an analytical nature, e.g. comparison of charts from 1783 to the present day and the examination of samples of bed and suspended material. In addition a survey of part of the main mud area has been carried out by the Station survey team in difficult conditions, parts of the area being soft mud covered by only 2-ft. or 3-ft. of water at high tide.

Construction of the model in the Main Hall is proceeding. This model will reproduce the whole area inside the harbour entrance and a certain area outside the entrance to scales of 1/480 horizontally and 1/60 vertically. Tides will be produced by a pneumatic tide generator.

## *Hydraulics Research Station at Wallingford—continued*

**The Mersey Estuary.**

An investigation of two major problems in the Mersey, is being carried out for the Mersey Docks and Harbour Board. An adequate depth of water is maintained in the Narrows and the approach channels to Liverpool by the large volume of water which flows into and out of the Upper Estuary as a result of the flow and ebb of the tide. Since 1861 the volume of this flow has dropped by 8 per cent. due to a decrease of that amount in the capacity of the estuary. Although the general trend has been one of deterioration there have also been periods of increasing capacity. It is necessary, therefore, to determine what factors control the capacity to forecast future trends and to estimate what effect these will have on the approach channels to the Port of Liverpool.

The second problem is concerned with the rapid silting which is taking place on Bromborough Bar in the approach channel to the Manchester Ship Canal and the new Queen Elizabeth II oil dock. With the construction of the oil dock it was necessary to cater for tankers having an arrival draught of 34-ft., by providing a channel 5-ft. deeper than that required previously. Early in 1953, however, conditions at Bromborough Bar showed signs of deterioration, the rate of accretion being abnormally high. Deepening was started in July, 1953, and up to December, 1955, 4,000,000 cubic yards of material were dredged from this area, but a net increase in mean depth of only 2-ft. was achieved. The aim is to find the source of this material, perhaps by using radioactive tracers, and, if possible, to suggest means of preventing it being deposited, or to find out whether the source of supply will be exhausted if dredging is continued.

Two models will be built to study these problems; one of the upper Estuary upstream of Rock Light, to a horizontal scale of 1/550 and a vertical scale of 1/60; and a smaller model, probably with a horizontal scale of 1/2000 of Liverpool Bay and the Upper Estuary. The first of these is under construction, and will have the weir type of tide generator recently developed at the Station. A special survey team, with a temporary laboratory in the offices of the Mersey Docks and Harbour Board, has been set up to collect and analyse information about the river.

**River and Estuary Hydraulics.**

In the field of river and estuary hydraulics the most difficult class of problems requiring solution is that concerned with scouring and shoaling and the attendant processes of channel instability. A feature of many rivers and estuaries is a deep water channel which is narrow compared with the total width of the river and which varies in position, usually in a cyclic manner. Basically the difficulty is that insufficient is known about the laws which govern the transport of sediment from place to place in flowing water so that schemes for channel control and improvement cannot be planned with confidence.

To study the problem in its simplest terms experiments are being conducted at Wallingford in a straight flume in which water is run over a bed of sand. The flume is of rectangular section and is sufficiently long to ensure that unavoidable disturbances due to the introduction of the water at entry will have damped out before the test length in which measurements are taken has been reached. A constant flow of water is circulated through the flume, the level at the downstream end being held constant by allowing it to flow over a weir. Sand is fed into the stream at the head of the flume at a steady rate. Some of this sand deposits on the bed and some is transported to the downstream end where it settles out in a deep basin through which the water passes before flowing over the weir.

This process is continued until the bed has risen sufficiently to restrict the flow, so increasing the velocity, until the rate at which sand is deposited in the settling basin is equal to the feed in rate. When this stage is reached the flow is said to be in equilibrium, i.e. the depth and velocity are such that the bed is neither silting nor scouring and the amount of solids flowing across any section is constant. Because of the great length of the flume (350-ft.) it is sometimes necessary to run for a very long time before equilibrium is attained.

The equilibrium state, besides being the simplest to study, is of great natural significance because it represents the state to which rivers and estuaries tend if left to themselves. Any disturbance of this state either artificially or by some natural agency leads to a gradual re-establishment of a new balance and a new equilibrium state. It will be possible by making measurements over a range of discharges and solid feeds to formulate laws for the equilibrium condition.

So far, fine sand has been used for these experiments. There are several reasons for this. Firstly, a good deal of information exists on the motion of coarser grades from earlier flume experiments. Secondly, fine sand is very prevalent on the beds of the lower reaches of rivers and also in estuaries, where river training problems are usually most acute. Thirdly, fine sand presents unusual features due to the very pronounced short bed ripples which accompany movement. Up to the present the reason for the ripples and the part they play in sand transport has not been studied in sufficient detail. The experiments will give a better understanding of their role and the way in which they affect the transport of material.

**Basic Coastal Model.**

A Basic Coastal Model is used to investigate why some beaches erode and why sand builds up on others, and also to assess the value of different coastal defence structures. It is difficult to compare the merits of different types of groynes and sea walls by observing their effect on real beaches because there are so many factors, other than the groyne or sea wall itself that simultaneously affect them. In this model all conditions are under control and alternative types of sea defence works can be compared under identical conditions.

The model beach is built to a horizontal scale of 1 in 30 and a vertical scale of 1 in 20. It is an idealisation of the beach at Dunwich in Suffolk. Extraneous ridges and troughs have been smoothed out, and all the contours are straight and parallel. A length of beach 3,000 feet long is represented, extending to 1,400 feet seawards. The tides and tidal currents that are reproduced in the model are scaled down from those appropriate to Dunwich. The wave-height is the equivalent of about 2½ feet and the wave periods 6½ seconds. These wave characteristics were not obtained directly from the site but were found by trial and error from experiments in which the object was to mould a beach of the Dunwich profile by wave action. The waves can be said to be equivalent to all the many waves reaching the Dunwich beach during a year with a bias towards the waves that had been working at it at the time immediately preceding the H.R.S. survey. The direction from which waves come has been arbitrarily fixed at 30° to the left of normal for the present set of experiments. The beach represents therefore one in which there is a steady drift of sand always in the same direction, the type of beach that reacts most readily to a system of groynes.

The model has recently been used to investigate the influence of a permeable screen consisting of spaced piles set parallel to the beach. The model showed it to have a small beneficial effect if the screen was erected at a point on the beach between high and low water. The deposit of sand was however small compared with the deposit found in the upstream compartments of an orthodox groyning system. The first system of groynes that was investigated reduced the rate at which volumes of sand travelled down the beach to a quarter of the normal rate. The measurement of this reduction is one of the main objects of the experiment because it is a necessary figure in the calculation of the manner in which a new groyning system fills up. The behaviour of different types of orthodox groynes is now being investigated.

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**Emergency Bunkering Arrangements for Mombasa.**

Following the closure of the Suez Canal, plans for emergency bunkering and watering at Mombasa have been agreed after discussions between the East African Railways and Harbours Administration, the shipping lines and the principal oil companies. The capacities of the oil installations are sufficient to cope with normal consumption requirements and also bunkering of ships not usually calling at Mombasa. A Ports Emergency Committee has been established to consider priorities, including the relative needs of ships requiring bunkers only and ships requiring berths for working cargo. The Railway Administration is duplicating the water mains in the port in order to double the normal rate of supply.

# Paddle Tugs for Admiralty Service

## Harbour, Towing and Salvage Duties

The Admiralty in their Tug Replacement Programme for 1955 planned to have built a series of seven new class Diesel Electric paddle tugs. The orders for the first four tugs were placed equally with William Simons & Co. of Renfrew, and Yarrow & Co. Ltd., Scotstoun, Glasgow, from whose yard H.M.T. "Director," launched in June of this year, has recently completed her trials.

It has been found by experience that paddle driven tugs are the most suitable for moving aircraft carriers and other large warships through dock entrances and in the confined waters of dockyard basins. To enable them to operate under the overhanging sides of aircraft carriers, the new tugs have been built with hinged masts, squat funnels and a raked back stem.

Of flush-deck type, with sheer forward and aft, the tugs, though intended primarily for harbour service, have been constructed under special survey, to Lloyds Class 100 A1 "for towing and salvage services," including assignment of loadline so as to enable them to proceed to sea. Accommodation, life-saving equipment, lights, signals, etc., are to the requirements of the Ministry of Transport and Civil Aviation, including measurement for British registered net tonnage.

Principal particulars of the vessels are as follows:—

| | |
|---|---|
| Length, overall ... ... ... ... | 157-ft. |
| Length, between perpendiculars ... ... | 145-ft. |
| Breadth moulded ... ... ... | 30-ft. |
| Breadth, overall ... ... ... ... | 60-ft. |
| Depth, moulded ... ... ... ... | 15-ft. |
| Draft, load ... ... ... ... ... | 10-ft. |
| Speed, running free ... ... ... | 13 knots |
| Bollard pull (estimated) ... ... ... | 15 tons |
| Displacement, load ... ... ... | 710 tons |

Accommodation is provided for a company of twenty-one comprising six officers and fifteen crew. Captain's cabin is sited on the bridge deck alongside the combined chart, wireless-telegraphy and radar room and close to the wheelhouse which is constructed of aluminium alloy in vicinity of the compass and fitted with Kent clear-view screens.

A deckhouse on the upper deck is arranged with cabin for chief-engineer, saloon, galley, pantry, bathroom, washplaces, etc. Also on this deck are drying room, lamp room, and a fan space. Accommodation on lower deck includes two double-berth cabins for officers, two cabins, with seven and eight berths, respectively, for crew, also crew's mess. At the after end are store and hawser rooms and steering gear compartment. Bosun's store is situated in hold, with access from upper deck.

To ensure good steering and manoeuvring qualities of the vessel, the rudder is of large area actuated by electric hydraulic steering-gear with control by telemotor installation from the wheelhouse and arranged for emergency hand steering. Deck machinery includes a 16 h.p. electric anchor windlass to suit 1.1/8-in. dia. chain cable for the 12-cwt. anchors and fitted with warping drum each side; also a 30 h.p. 24-in. dia. electric after-warping capstan.

Two towing hooks of "Monarch" patent shock-absorbing type, each tested to 50 tons, are fitted at after end of bridge deck, with guide rails and stops.

Two 16-ft. lifeboats, complying with Ministry of Transport requirements, are carried on bridge deck. Boat davits are of "Schat" single-arm radial type, with hand-operated lifting and turning-out gear.

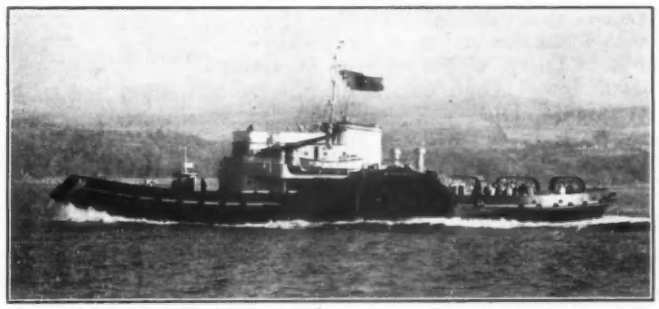
Heating throughout accommodation is by electric radiators, of panel type, together with slow-combustion coal stoves as a secondary means of heating in the principal compartments. Ship ventilation arrangements include motor-driven fan supplies to accommodation, offices, etc., with fan exhaust from gallery, pantry, bathrooms, etc. An adequate supply of hot water, for cabin, galley, pantry and bathroom use, will be available from a 50 gallon electric calorifier circulating system, an oil-fired boiler being provided, in the galley, for secondary use. Refrigerator is of standard domestic-automatic type.

Means of communication throughout is by voice-pipe, with sound-powered telephones between wheelhouse and machinery spaces, etc. Two signalling projectors are carried and the vessels are fitted for echo-sounding.

Fire-fighting equipment includes two monitors and two foam distributing heads, served by the 150 tons/hr. salvage and fire pump. In addition to this pump and the two 30 tons/hr. bilge and fire pumps, fitted in the engine room, a portable diesel-driven fire pump is carried, together with two portable 70 tons/hr. electric pumps for salvage duties. The fire and salvage pump is arranged to discharge foam compound to two Pyrene distributing heads and to two monitors as well as the usual water for fire and wash deck services.

**Machinery Installation.**

The propelling machinery in each of these vessels consists of four diesel generators connected in series with two independent propulsion motors. The diesel end of each propulsion generator is a Paxman Type 12 YHAX engine. The electric end of these generators (339 K.W. 305 volts 1600 r.p.m. machines) together with the



H.M. Paddle Tug "Director" on trials.

propulsion motors, exciters, control gear, and ancillary equipment are all of British Thomson-Houston manufacture. Each of the propulsion motors transmits up to 800 h.p. (212 r.p.m. and 600 volts D.C.) through a Renold chain drive of about 8 to 1 reduction ratio to the independent paddle shafts and each motor can be controlled from either the bridge or the engine room. A feature of the controls is the provision whereby the operator can select the more suitable of two power characteristics for the particular towing conditions at any time. For normal harbour service the shafts will be independently operated but a dog clutch is provided for coupling them together quickly should the vessel require to proceed to sea. A flexible coupling is fitted between each motor and its pinion shaft and a semi-flexible coupling is provided in each paddle shaft. The pinion and wheel shafts are supported on roller bearings. The paddle wheels are of the feathering type with star centre arranged inboard and on the paddle block.

The principal auxiliaries include a motor driven air compressor and a diesel compressor, both of Reavell make; a diesel oil transfer pump of Hamworthy make, and two Alfa Laval oil purifiers.

**New Oil Terminal at Bombay Nearing Completion.**

The marine oil terminal now under construction at Butcher Island, 3½ miles east of Bombay, is nearing completion. Costing over £7.5 mn., the terminal will be the first of its kind east of Aden, and will provide modern berthing and discharging facilities to tankers drawing up to 34-ft.

The terminal consists of three deep-water berths capable of receiving tankers at any state of the tide. Each berth is formed by a pair of breasting dolphins with a pierhead between and an approach gangway of reinforced concrete, running parallel to the dolphins, on which the pipelines and a roadway are carried. The jetty is L-shaped and is 1,600-ft. long. The longer arm is so constructed that when tankers are tied up they are in line with the tidal flow. Two of the berths are already in operation and the third is expected to be ready next year.

Six submarine pipelines, each 2½ miles long, connect the terminal with the Stanvac and Burmah-Shell refineries located nearby. Three of the pipes are 24-in. in diameter, two are 16-in. and one is 12-in. A fresh water pipeline has also been laid down.

# The Design of Tidal Outfalls

## Basic Principles and Factors

By R. BERKELEY THORN, B.Sc., A.M.I.C.E., A.M.I.Struct.E., A.M.I.W.E.

### 1. Outfall Hydraulics.

Despite the extensive use of tidal gravity outfalls in drainage works of various kinds the subject of their design is sadly neglected in standard text books on hydraulics. This short article therefore sets out briefly the main factors that have to be taken into account in order to determine correctly dimensions and details necessary to ensure that a proposed outfall will function satisfactorily. To follow the methods described, all that is required is a knowledge of elementary hydraulics and an understanding of the use of Energy of Flow curves. Conditions of flow through an outfall may be grouped into five main categories (see Fig. 1) as follows:—

**Case I.**—Outfall discharging freely, culvert flowing partly full, and culvert slope equal or greater than slope required for flow at critical depth. Under these conditions the outfall acts as a broad crested weir and its discharge may be calculated by the standard broad crested weir formulae.

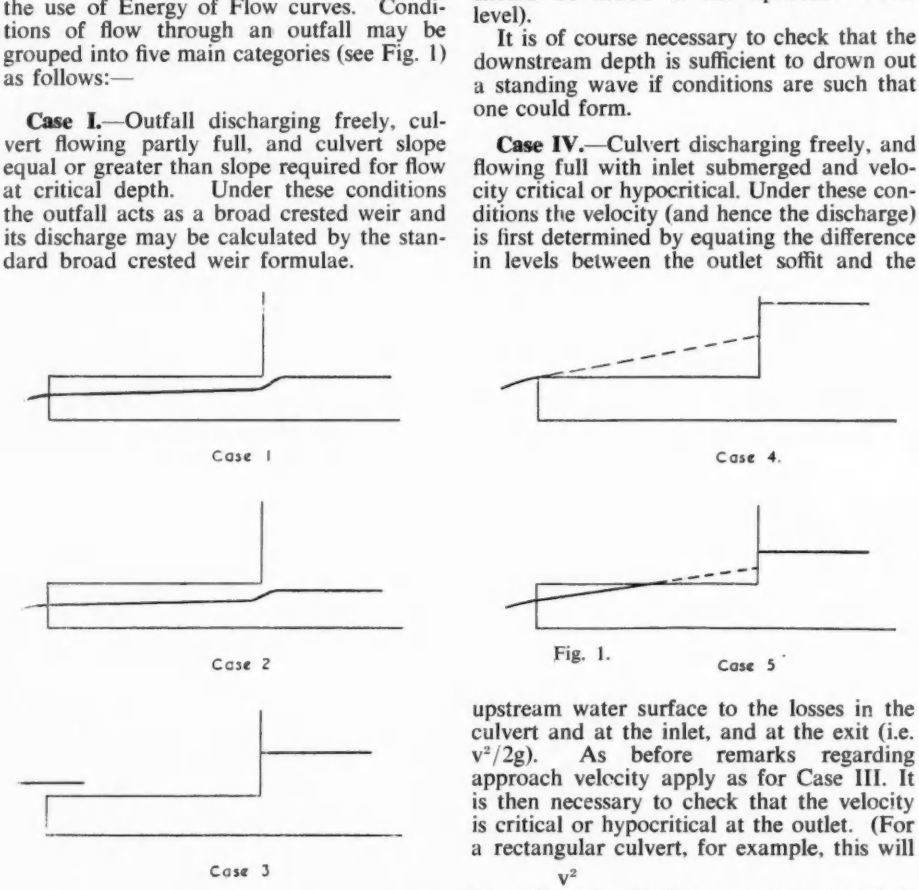



Fig. 1.

**Case II.**—Outfall discharging freely, culvert flowing partly full and culvert slope less than slope required for flow at critical depth. In this case flow is critical at the outlet end and sub-critical upstream of the outlet. To determine the depth of water at the inlet required for a given discharge, the critical depth corresponding to the discharge is first plotted at the outlet. The culvert is then divided into suitable lengths and the slopes of the water surface and energy of flow line are determined having regard to the discharge, depth of flow and the rugosity coefficient. At the upstream end allowance is made for entrance loss.

**Case III.**—Culvert flowing full, and with outlet and inlet submerged. This is the simplest case where in order to determine the velocity, and hence the discharge, the difference between the upstream and downstream water levels is equated to the losses in the culvert, usually entrance loss, exit loss and loss due to turbulent flow along the culvert (if there is an appreciable approach velocity then the velocity head it represents should be added to the upstream water level).

It is of course necessary to check that the downstream depth is sufficient to drown out a standing wave if conditions are such that one could form.

**Case IV.**—Culvert discharging freely, and flowing full with inlet submerged and velocity critical or hypocritical. Under these conditions the velocity (and hence the discharge) is first determined by equating the difference in levels between the outlet soffit and the upstream water surface to the losses in the culvert and at the inlet, and at the exit (i.e. $v^2/2g$). As before remarks regarding approach velocity apply as for Case III. It is then necessary to check that the velocity is critical or hypocritical at the outlet. (For a rectangular culvert, for example, this will be so if $\frac{v^2}{2g}$ is equal to or greater than half the height of the culvert).

**Case V.**—Inlet submerged, and culvert flowing partly full at seaward end. If these conditions obtain and it is required to find the head upstream for a given discharge, the procedure is very similar to that adopted for Case II, that is, the critical depth corresponding to the discharge is first plotted at the outlet. The culvert is then divided into suitable lengths and the slopes of the water surface and energy of flow line are determined having regard to the discharge, depth of flow and rugosity coefficient. Upstream of the point at which the water touches the roof the loss of head is calculated as for turbulent flow in a conduit flowing full, and allowance is made at the upstream end for entrance loss.

### 2. Storage.

During the tide-locked period the water level upstream of the outfall rises and the flow is stored above the water surface line existing at the end of the tide-free period. The line representing the water surface at maximum height attained during tide-lock is called the pondage level.

For the outfall to be satisfactory there must be adequate storage to contain the flow during the tide-locked period without raising the water level too high (e.g. to a level to cause serious flooding). It is usually found that the private ditches draining into the main watercourses store a large proportion of the tide-locked flow, and for storage calculations their reservoir capacity cannot usually be neglected. It follows that the outfall must be of sufficient capacity to evacuate during the tide-free period all water stored during the tide-locked period together with the continuous run-off carried by the channel. The greater the difference in levels between pondage water surface and water surface at end of tide-free period the greater the storage available. The water surface at end of tide-free period depends on the discharge capacities of the outfall and the channel, the greater their discharge capacities the greater is the storage available.

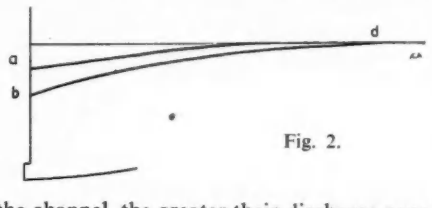



Fig. 2.

The evacuation of stored water is usually studied by a step-by-step method. The pondage depth at the outfall at the end of the tide-locked period is divided into suitable intervals, illustrated diagrammatically as a-b in Fig. 2, the discharge capacities of the outfall for the two depths represented by a and b are calculated and the water surface gradients for these discharges are roughly determined and plotted (a-d and b-d).

Point d having been found where the two surfaces approach closely, the gradients are calculated more accurately by considering the flow a maximum at the outfall and reducing by suitable amounts to the continuous run-off flow at d, the reduction in discharge being proportional to the storage capacity between a-d and b-d over the length considered. If the position of d so determined differs greatly from that found by the initial calculation on which the proportional reduction in discharge was based then it is necessary to re-calculate the gradients on the amended value of the length a-d in order to determine them more accurately. Water surface a-d would in practice normally have been already determined by a previous calculation.

## *The Design of Tidal Outfalls – continued*

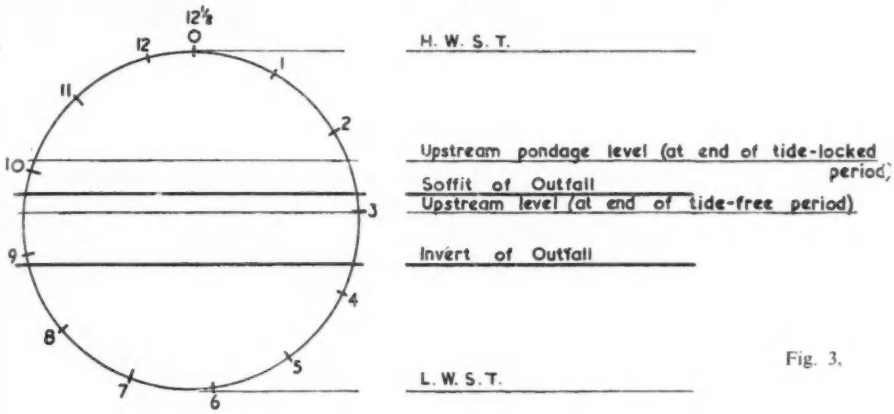



Fig. 3.

The volume of water stored between a-d and b-d is next found and this volume divided by the average discharge between a and b less the continuous flow gives the time for the water level to drop from a to b. This method gives the rate of fall of the upstream water level and from this the upstream level at which tide-lock commences again can be determined. If the discharge capacities of the outfall and channel are adequate then the storage available between the pondage water surface and the water surface at end of tide-free period will be equal to the total volume of water entering the system during the tide-locked period.

Frequently it must be assumed that the sea wall or river wall through which the outfall is constructed will on rare occasions be overtopped during exceptionally high water resulting, for example, from surge conditions in the sea. In these circumstances it is usual to construct an outfall of sufficient capacity to evacuate flood water to a depth of several feet over the land in a period of a few days, the depth of water taken and the period for evacuation depending on the site circumstances.

### 3. Tide Levels.

Provided that the rise and fall of the tide conform to simple cosine curves, the tide curve over selected periods may be plotted from the information given in the Admiralty tide tables. Alternatively, the information may be obtained from tide level recorders or direct observations. The behaviour of a proposed outfall may then be studied under selected tide and run-off conditions. A preliminary study may often be limited to a few critical conditions, for example, conditions on spring or neap tides, in which case the periods of tide-free, tide-locked and partly tide-locked conditions may be quickly ascertained approximately from a diagram similar to that shown in Fig. 3.

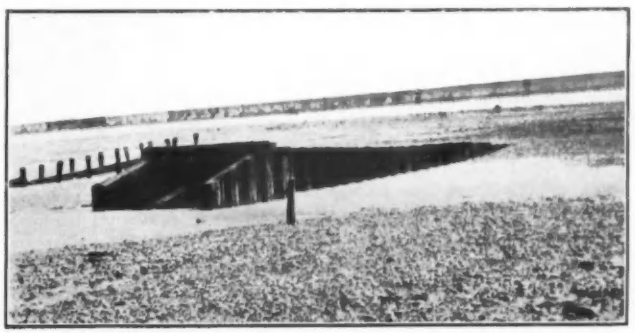
A circle of diameter representing, to scale, the difference in height between high and low water is drawn and, starting from the top, the circumference is divided into 12½ intervals, representing the tidal period in hours (or whatever other tidal period is applicable). Horizontal lines are then drawn representing the soffit and invert of the outfall, upstream pondage level, upstream level at end of tide-free period, and other levels between these two if required. Horizontal lines drawn through the time intervals marked on the circumference give the tide levels corresponding to the times, and the tide-locked and tide-free periods may then be simply determined.

### 4. Structural Details.

The smaller outfalls may consist of cast iron pipes with flexible joints under the sea wall or river wall and supported on piled bents on the foreshore; or of concrete pipes with flexible joints under the wall, bedded and haunched in concrete and connected by steel bars running through the concrete bed and wrapped with Denso tape or similar material at the joints to prevent corrosion.

Larger outfalls may comprise large diameter concrete pipes with concrete surround constructed between, and joined by hook bolts to two parallel rows of steel sheet piling, the piling aiding excavation in poor sub-soil during construction, and providing anchorage on the foreshore against wave action and sometimes against buoyancy. Flexibility at the joints is assisted by including expansion joint material in the concrete surround. For temporary outfalls timber may be used. Sometimes, where conditions are suitable, the culverts are supported under the wall on piled foundations.

Main outfalls are usually single or multiple barrel reinforced concrete box culverts. Bending moments are best determined by the moment-distribution method. Steel sheet piling is usually employed for the reasons given and under the wall for flexibility the culvert is divided into short lengths by expansion joint material, each joint coinciding with pile clutches and being made watertight by a rubber water stop (the



Typical Outfall under construction. Steel sheet piling driven (bottom left) floor and wall reinforcement placed (bottom right) and view of seaward end after construction (top right).

## *The Design of Tidal Outfalls—continued*

continuity of the steel sheet piling is maintained).

On the larger outfalls it is frequently the practice to include a tide flap chamber immediately behind the wall, the top of the chamber rising above highest known tide level. Each barrel of the culvert is then provided with two tide flaps, one at the seaward end and one in the tide flap chamber, the second one preventing ingress of the tide in the event of damage occurring to the seaward flap. The tide flap chamber cover should be perforated to allow the escape of air compressed in the culverts as waves shut the tide flaps frequently and suddenly at the commencement of the tide-locked and tide-free periods. Multiple barrel culverts have the advantage that repairs may be carried out on one barrel while flow continues in the other barrels.

On many exposed outfalls the seaward flap is not provided and reliance is placed on the tide flap in the flap chamber and on an emergency sluice gate at the landward end.

On the smaller outfalls, the tide flaps may be of cast iron or timber. On the larger outfalls they usually comprise an outer skin of vertical timber, felt, and an inner skin of horizontal timber, the whole strengthened by mild steel angle or channel bracing with steel suspensions; impact protection is provided by rubber strips fixed round the inner edges of the tide flap. Flaps are normally top-hung, but in unexposed positions (in a protected tidal estuary, for example) side-hung doors are sometimes used. Frequently for large outfalls at very exposed sites no tide flaps are built in the culvert. With this arrangement a tidal basin is constructed at the upstream end of the outfall and tide flaps or pointing doors are provided at the upstream end of the basin in a position not in line with the culvert.

Where sluice gates are installed at the upstream end of culverts it may be necessary, when the head exceeds about 10-ft. to provide an air vent immediately downstream of the sluice. The vent allows air to escape as the hydraulic jump moves upstream during the transition period from part full to pressure flow. Similarly the vent introduces air during the transition period from pressure flow to part full flow. The cross sectional area of the vent should be about 10 per cent. of the cross sectional area of the outfall.

# Containing Spilled Oil at Ports

## Still-Boom of Foam-Filled Hose

By J. GRINDROD

With the increasing quantities of oil being loaded or unloaded at ports or in harbour basins the risk of spilled oil from leakages spreading from the immediate vicinity of loading or discharge operations has also been correspondingly increased.

Such risks have emphasised the necessity for some arrangement which would prevent this from occurring and which would make possible the " lacing-up " of the oil so as to facilitate its being sucked up by pumps or injectors.

So far, such appliances have often taken the form of a series of connected floating timbers or long plate booms which are towed out to the spot where the oil has been spilled. In the United States, cork-filled hoses of asbestos fabric are being used. These hoses are stored in disconnected 30 m. lengths, and, when used, the lengths are coupled together and are towed out to the place where the boom is needed. Experiments have also been made with hoses continuously filled with $CO_2$ gas. All these types of booms, however, not only make great demands upon storage space, but also on available staff and means of transport.

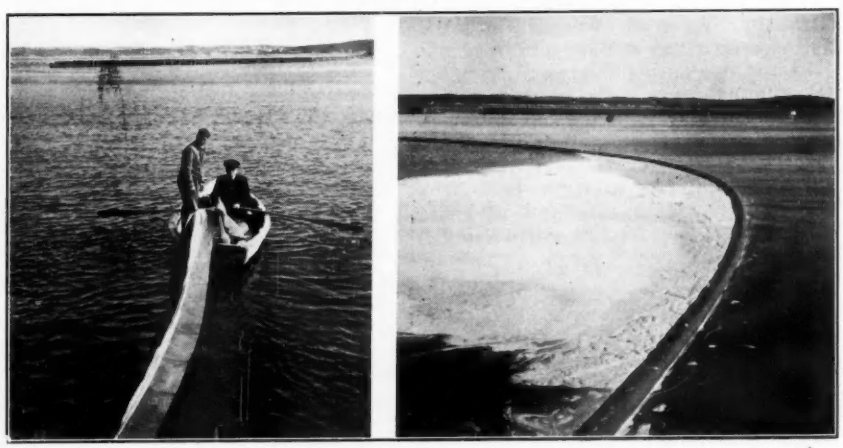
In Sweden, a prototype of an entirely new kind of device has now been manufactured by the Fire Department of Aktiebolaget Pumpindustri, of Göteborg 5, which is based on an idea put forward by a Nynäshamn engineer, Mr. A. Wicklander.

This so-called still-boom consists of a neoprene-impregnated nylon fabric hose with a diameter of about 150 mm. The hose is provided with a fin of soft fabric, with a depth of about 20 cm., which, in turn, is fitted with lead cords, hemmed in at the base. Produced in 100 m. lengths, the hose is provided with 125 mm. Storz couplings. At intervals of 10 m. the still-boom is equipped with plainly visible handles and arrangements for mooring connections.

In storage, each hose length is kept in a hose-bag made of tarpaulin-fabric and provided with a lid and carrying handle. The hose packed in the bag has a weight of about 90 kg. and requires a space of 80 x 30 x 80 cm. Completing the still-boom are steel plate, anti-rust treated floats provided with a tube-body, equipped with 125 mm. Storz fittings, to each end of which a hose can be connected. The floats are provided with a carrying handle as well as eyelets for anchoring ropes.

In use, the hose is filled with foam from a pressure-foam-nozzle with a capacity of about 2,000 l/m. The foam is led from the foam producer through a normal 63 mm. fire hose to the still-boom hose by way of a section which makes possible the transition from the 63 mm. standard coupling to the 125 mm. Storz coupling. The pressure-foam-nozzle is provided with a pick-up arrangement for the foam liquid. The nozzle has a water consumption of about 300 l/m. at 8 to 10 kg./cm$^2$. An ordinary motor fire engine can be used for the water supply.

The laying of the still boom on an affected part of the harbour basin can be made by one man only, using a small row-boat, if a motor boat is not available. The filling up with foam to a distance of 100 m. takes 1½ to 2 minutes. The pressure-foam-nozzle is capable of filling up at least 200 m. of hose with foam. Should a longer still-boom be required, the hose can be filled up in sections,



(Left): The hose being laid by two men in a row boat. (Right): The foam filled hose keeps the polluted area within bounds.

which are connected by means of the floats previously mentioned. In such a way a closed ring can be arranged.

During experiments the hose has been tested in water up to 48 hours, after which period of time it was still filled with foam and air. Refilling with foam does not present any difficulty. The still-boom being flexible and fitted with the soft fin, it always rides easily with the waves.

Although the risk of fire in such instances is not of the first importance, it is being borne in mind by AB Pumpindustri, who are continuing their experiments in order to produce a fire-proof foam hose. Very recently the company made a test with a foam hose made of plastic glass fibre fabric, which was laid out in the basin used by them for fire-fighting experiments. The hose was subjected to intense heat by igniting the oil. It was found on examination that the plastic had melted to some extent, but the hose was not damaged. AB Pumpindustri intend to pursue their investigations in this direction.

# Hydrographic Surveying for Civil Engineering Development

*(Continued from page 242)*

In the November issue of this Journal we published a paper with the above title, by Lieut.-Commander A. D. Margrett, R.D., R.N.R., which was read at the Royal Institution of Chartered Surveyors on 15th March, 1956. The following is a report of the discussion which followed.

**Commodore K. St. B. Collins, R.N.** (Hydrographer of the Navy: Visitor) asked that the congratulations of the Hydrographic Department and of the Naval Surveying Service be conveyed to Lt.-Cmdr. Margrett for a most interesting paper; of particular interest, be it said, to the Surveying Service to whom large-scale surveys were a continual challenge. He suggested that the harbour surveyor had a routine method of carrying out his surveys of docks, basins, jetties and anchorages. In fact, a routine method was necessary, as it was essential to be able to compare the new survey with previous ones in detail, line by line. But in the case of the hydrographic surveyor, trained to deep sea and coastal survey methods, the large scales of docks surveys were a challenge to his ingenuity and improvisation. He mentioned one instance of such ingenuity: the occasion was a river survey. An anchor was laid upstream and the cable brought inboard just abaft the bows of the sounding boat. By inclining the bows at an angle to the stream, the boat moved slowly across the river, the surveyor sounding and fixing the while. On arrival at the other bank, the boat was warped up on the cable the requisite 20-ft. between lines, the cable secured to the other bow, and the stream carried the boat gently back again—a most unusual but seamanlike method of carrying out the survey. One very important weapon in the surveyor's armoury had not been mentioned by Lt.-Cmdr. Margrett, and that was the diver. In the Hydrographic Service it was found that the surveying of a jetty or wharf could seldom be called complete, however, extensive the sounding and careful the sweeping, unless a diver had inspected the sea bed. He could investigate and identify obstructions, however small they might be, and even though there be none, the report of his inspection gave a feeling of security that was absent with the lead, echo and sweep alone.

**Lt.-Cmdr. D. L. Gordon, R.N.** (Fellow) observed that there was considerable divergence of opinion regarding the reliability of model experiments and he thought that it was putting it rather too strongly to say that movements could definitely be forecast months or even years ahead.

He could not agree that chart datum was an accurately defined level; in spite of the internationally accepted resolution on the subject, these levels varied widely from place to place; for instance, in the U.S.A. nearly half of all low waters fell to datum or below, while at the majority of French ports the tide seldom, if ever, fell to datum.

Another point was the use of the word "current" which in this country was usually understood to refer to non-tidal movements of the water; for tidal movements the Admiralty used the expression "tidal streams," though the Americans referred to "tidal currents."

**Mr. T. Convey** (Professional Associate) referred to the excellence of modern echo-sounding gear specifically designed for large-scale survey work, and using the important physical constant of the speed of electrical impulse through water of a known density as a basis for its accuracy; for, within certain limitations of total depth, where working over a hard bottom, the vertical measurement could in fact be interpolated to within $\pm 0.25$-ft. That could well be regarded as near perfection of practical value, particularly when considered as a zone of continuous recording of the bottom, disclosing sudden changes of gradient, peaks and crevices essential to pricing a large hydro-civil engineering project. The close values obtainable in the vertical measurement should, however, be matched by a comparable horizontal value or positional fix. From experience in minor work of that character, it was noted that, in order to maintain accurate course along the produced line of sight of a pair of shore transits, a running speed of about 6 knots was a minimum necessity in order to maintain station, particularly when crossing even medium tidal currents. Bearing in mind that two observers taking so-called simultaneous sextant angles were using hand-held instruments on a moving platform, dependent for course accuracy on a third person, the coxswain, and upon a fourth person operating the electrical time fix on the echo sounder, Mr. Convey suggested that there was a possibility of $\pm$ mental error which might cause a positional displacement tending to nullify the vertical accuracy value; and which, it was suggested, could be 25-ft., or more, according to circumstances. Whilst, in the general hydrographical sense, that point might be regarded as pedantic, it might be of interest, in view of the title of the paper under discussion, to know whether any scientific check had ever been applied to the traditionally accepted fixing procedure in large-scale surveys required for civil engineering development.

**Mr. A. J. Rusk** (Fellow) said that echo-sounders, both wet and dry paper types, had been regularly and frequently used on the civil engineering work for developing the port of Mombasa. Some engineers, not fully acquainted with the echo method, might hesitate to rely on it. During the four years of work, the echo-sounder proved itself to be reliable and accurate, when correctly used, and latterly was preferred to chain and lead. Speed of operation was important where watch was kept on movements of deep deposits of tidal mud. Under critical conditions, repeat plans of area were required at regular intervals, perhaps weekly.

East of operation was also an advantage. During the critical period, part of the area was sounded by chain and lead, the leadsmen working off small rafts working along taut lines. Urgent needs were met by 12-hour days for a period. It was found that physical fatigue of the trained leadsmen was a limiting factor. In short, the echo-sounder proved to be a most reliable and useful adjunct to large-scale civil engineering work in a harbour area.

**Captain E. G. Irving, R.N.** (Assistant Hydrographer: Visitor) mentioned the use of electronic aids for certain aspects of hydrographic surveying and said that the Decca Navigator, for instance, enjoyed the special property of "repeatability" which would contribute to the solution of problems of fixing off-shore in connection with the surveys of dumping grounds, dredged areas or harbour bars, where regular or frequent resurveys and the erection of special marks were required, or in areas of low visibility.

The Decca lattice pattern, being very stable, would be connected with the hydrographic triangulation by comparing visually fixed positions with the Decometer readings and establishing the differences. The Decca lattice could then be enlarged to a scale large enough for most off-shore surveys, especially if plotted from the computed co-ordinates.

The advantages, where the system was already in existence, were that the area could be re-surveyed as often as required and with the least possible effort in preparing special marks.

Captain Irving then mentioned the need for prompt information being sent to the Hydrographic Department and asked that all concerned with surveys of new or existing harbour works should send results in order that Admiralty charts could be kept fully up-to-date. Due acknowledgment would always be given.

**Mr. R. M. Stephenson** (Messrs. Kelvin and Hughes: Visitor) pointed out that Lt.-Cmdr. Margrett's paper dealt mainly with hydrographic surveying in areas where facilities were less developed. In remote sites, the economics of commercial surveys rarely permitted the use of divers and elaborate equipment for position fixing, and that explained why reference to such facilities was omitted from the paper.

**Lt.-Cmdr. J. F. Nicholson** (Professional Associate) commented on the section of the paper entitled "Methods of Survey." There, Lt.-Cmdr. Margrett stated that it was impossible to plot fixes afloat and con his vessel when working on large scales, such as 1/2500. In Southampton Water, the great majority of surveys were carried out on a scale of 1/2500, and some even on double this scale, viz., 1/1250. In all cases plotting was done while surveying, and that was particularly necessary when checking dredging and dredged channel margins, in order to have precise knowledge on the spot, of the ship's position and the extent of shoal areas.

Working on these comparatively large scales necessitated frequent fixing, say at every 30 seconds, or even more often on occasions, but it was found that providing one had two experienced observers, and the shore objects were ideally conditioned, that could be done, the senior surveyor taking one angle and plotting it, and the other observer taking the second angle and logging fixes. That certainly was a bit laborious when plotting with station poin-

## *Hydrographic Surveying—continued*

ters, but by using sextant plotting graphs it was found to be relatively easy.

For this type of survey, transit marks were not erected, but lines were run on natural transits wherever possible: otherwise, magnetic compass courses were worked on. The speed of the vessel on these surveys averaged 4—5 knots, but a steady speed was maintained throughout any particular survey.

In connection with relatively high-speed fixing on a survey, Lt.-Cmdr. Nicholson mentioned that successful experiments had been made by keeping a tape recorder running during the survey, which recorded all fixes, times and any orders given to the coxswain—in fact, anything said during survey, so that, in a case of emergency, one could fix at 10-second intervals, if necessary, and plot an occasional vx at the beginning and end of each line as a check. Back in the office, the record could be played back as often as desired, and plotting completed at leisure.

**Captain H. Menzies, R.N.** (Fellow) queried the accuracy implied in civil engineering hydrographic surveys which showed soundings to an accuracy of 3-in.

Although there was no doubt that modern echo-sounding machines with an open scale could be read to such an accuracy, trouble arose when such soundings had to be reduced in accordance with readings on a tide pole. The illustration shows such a tide pole with the water level rising and falling on it quite considerably, and although an experienced reader could make a shrewd estimate of the true water level, he thought that reduced soundings would be subject to an error of at least ± 3-in.

**Brigadier A. H. Dowson** (Fellow) said he would like to add another land surveyor's voice to the discussion. In view of the remarks of Commodore Collins, it seemed that, though the land surveyor's trigonometrical stations and other shore marks could help the deep-water hydrographic surveyor, they did not seem to be as necessary for the harbour surveyor. Nevertheless, it was gratifying to know that the harbour authorities of at any rate the big ports in Great Britain found that the Ordnance Survey marks were of great value. No doubt the levelling information was also a help.

He wished to mention an example of help in the reverse direction: the Ordnance Survey trigonometrical surveyors now working on the north-west coast of Scotland and in the Outer Hebrides had been given the use of a Royal Navy motor launch for which they were very grateful.

Finally, he had yet to understand how it was possible to take soundings accurate to 3-in. from a craft which was heaving about on the seas.

**Commander Alun Jones, R.N.** (Fellow), who proposed the vote of thanks, said that the paper marked an important stage in hydrographic surveying development. The duties of the Admiralty hydrographic surveyor had never been related to profit and loss. For the Harbour Authority hydrographic surveyor, the financial considerations were important, and even though "profits" did not come into the question, "costs" had to be carefully considered. But Lt.-Cmdr. Margrett's paper had dealt with the activities of a totally new branch of hydrographic surveying, namely the commercial concern carrying out "contract" surveys. In such circumstances, the "profit and loss" factor was one of major importance, and was a governing feature in the operations. They were therefore welcoming a third member of the hydrographic surveying family—a member that had to operate profitably to exist.

Commander Jones thought that Messrs. Kelvin and Hughes were the first firm to undertake hydrographic surveys commercially. Competitors would undoubtedly appear in due course, so the third branch was likely to expand in the near future. The importance of the backing of a professional institution to hydrographic surveyors in this new branch was obvious. The boundary between the interests of the hydrographic surveyor and those of the civil engineer was not always well-defined, and that could lead to friction. It was therefore of importance that a professional qualification, recognised and accepted by other professional bodies, should be available to the hydrographic surveyor, and that the surveyor should have the protection of his institution in matters relating to his profession. Furthermore, it was obviously desirable that the public should be provided with a "yardstick" with which to measure the competence and professional ability of the surveyor, and that could best be provided by an institutional qualification.

He felt that Lt.-Cmdr. Margrett was very aware of this need for institutional backing for the hydrographic surveyor employed on contractual surveys, and that that awareness had given him the courage to present his admirable paper in this surveying stronghold. He therefore had pleasure in proposing the vote of thanks to Lt.-Cmdr. Margrett for his excellent paper, and to Mr. Gow for deputising so efficiently.

Summarising the discussion, the Chairman, **Commander D. H. Macmillan** (Fellow), said that the most important consideration in hydrographic surveying was the marrying of the sailor's art to that of the land surveyor and applying the best nautical principles to all the projects requiring them.

He pointed out that the development of deep-water terminals required a great deal more precision in survey than had been found necessary in the earlier part of the century.

It was very necessary for the sailor to keep a literal "weather eye" on the design, location and improvements of works carried out by engineers in modern enterprises. He cited as an example the estimation of the direction of windward "fetch" along the axis of the strongest prevailing gales as a very important matter in the lay-out of sea terminals. He referred to local examples of failure to estimate windward fetch over prevailing gale directions, and of dredging so closely inshore as to cause the loss of large areas of foreshore and sea walls adjacent on lee shores.

Referring to the statements in the paper about echo-sounding accuracy to 3-in., he thought this should probably be corrected to an accuracy of ± 3-in. under those ideal conditions of weather which should be exploited by the rapid echo-sounding techniques now available.

On the other hand, if this accuracy was to be attained, it meant close adjustment of stylus speed to mean salinity and temperature on the site, using a tachometer, meticulous accuracy in the determination of "water-line zero" by accurate reflector bar-check (using precisely calibrated wire depth lines), the close spacing of carefully levelled visual tide poles representative of the sounding site, and very accurate tide readings under smooth sea conditions. Vice-Admiral Sir Archibald Day, when Hydrographer of the Navy, had inspected his techniques at Southampton, and had agreed that under ideal circumstances, with every precaution taken, the claim of accuracy to 3-in. was valid.

With regard to the accuracy of simultaneous double-angle fixes using large scales, there would be no difficulty whatsoever in obtaining this accuracy on a scale of 1/2500 or even 1/1250, especially with sextant graphs, providing observers were to stand closely above one another and over the echo-sounding oscillators, and had been rigorously trained to take observations sufficiently often to limit the linear interval between fixes to reasonable values.

In addition, the shore control objects adjacent should be so positioned as to minimise displacement errors due to insensitivity of angles. If these conditions are observed, there is no real difficulty in surveying on these large scales, as accuracy would be well within plottable limits.

He emphasised that all these possibilities were entirely dependent upon observing the most meticulous accuracy in applying the several precautions he had outlined, but if that was done and fine weather periods were fully exploited, a very accurate and economic programme could be achieved.

He concluded by stating that all surveyors should be grateful for any developments on this matter, such as the paper by Lt.-Cmdr. Margrett, and that the application of proved hydrographic methods to the kind of work referred to could only be to the advantage of all.

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**Increased Oil Facilities on Tyneside.**

A riverside site occupying 60 acres is being acquired at Howdon, North Shields, by the Esso Petroleum Company for the construction of a major oil distribution centre to serve the North-East area. Berthage for tankers of at least 26,000 tons deadweight will be provided, while the storage installation will extend some 700-ft. back from the river. Of the 60 acres required, 47 are being acquired from Tynemouth Corporation and negotiations are in hand with another owner for the sale of the remaining 13 acres.

# Electricity for Vancouver Island

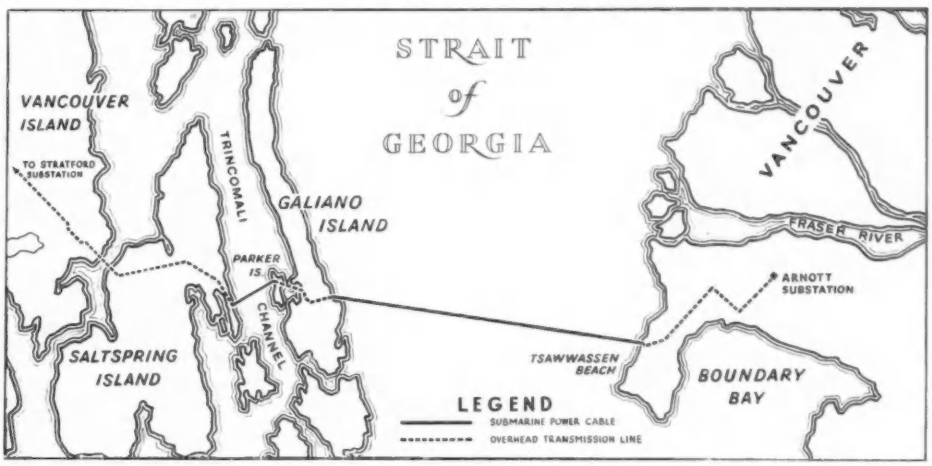
## Bulk Supplies by Submarine Cable

*(Specially Contributed)*

On 25th September last, the Prime Minister of British Columbia, the Hon. W. A. C. Bennett, officially switched in a supply of bulk electricity from the mainland of British Columbia to Vancouver Island. This important event signified the completion of an outstanding example of British-Canadian joint enterprise.

Since the war, the growth of industry in British Columbia has been extremely rapid, creating demands for greater supplies of electrical energy. The mainland of British Columbia is rich in power resources but the neighbouring Vancouver Island is not so fortunate and the Island's power supply problems were becoming acute. Mr. Tom Ingledow, at that time Chief Engineer of the British Columbia Electric Co. Ltd., which supplies electricity to both the greater Vancouver area and the southern half of Vancouver Island, conceived the idea of solving these problems by means of a power link from the mainland to Vancouver Island. The total length of such a link would be comparatively short, less than fifty miles, but would include a number of sea crossings, the major one, across the Strait of Georgia being approximately fourteen miles across with a maximum depth of 100 fathoms.

This scheme presented a problem: could a high-voltage submarine cable capable of supplying sufficient power be made and laid? A preliminary approach was made to the British Insulated Callender's Cables Group in 1952 regarding the feasibility of such a scheme. The problem of long submarine cables was one in which BICC had been actively interested for some considerable while and they were at that time engaged in investigations for the Central Electricity Authority relating to the proposed Cross-Channel Power Cable. In consequence, they were in a favourable position to deal effectively with such a project. When, at a later date, a formal enquiry was received from the British Columbia Electric Company, BICC were able to put forward positive proposals, resulting in their being awarded in February, 1954, an order worth approximately three and a half million dollars for the supply and installation of some 91 miles of high-voltage single-core submarine cable.




Map showing route of power link between the mainland and Vancouver Island.

On the mainland of British Columbia, high voltage power is transmitted at 230 kv., whereas on Vancouver Island it is transmitted at 132 kv. It was decided that the power to be carried by the cable link, 120 MVA, should be transformed down from 230 kv. to 138 kv. on the mainland and fed to the link at this latter voltage.

Long lengths of submarine cables capable of carrying high power had already been made and laid elsewhere, but these cables had all required large numbers of joints in the conductors, insulation and sheathing, which introduced potential sources of weakness into the cables. The most desirable form of cable, therefore, was one that could be made in one continuous length without any joints. Obviously, to produce a cable of this type would create manufacturing problems of a very difficult nature besides requiring much special plant. The most satisfactory solution to these problems was to use the single-core gas-filled pre-impregnated paper-insulated type of cable which has already given a very satisfactory service on land. The use of pre-impregnated paper overcomes the difficulties incurred in impregnating very long lengths in tanks.

Gas-filled cables for use on land are usually operated at 200 lb./sq. inch pressure. However, at the maximum depth at which the cable would be laid the external pressure on the cable would be as great as 280 lb./sq. inch. In the event of external damage to the cable sheath, the internal gas pressure must be greater than the external hydrostatic pressure, so that gas will flow out of the cable hence preventing an ingress of water. In view of this, the gas pressure decided upon for this cable was 300 lb./sq. inch. The subjection of parts of the cable to these high pressures made a hard compact form desirable. Thus, instead of following the normal practice in single core gas cables of having a slight clearance under the lead sheath to facilitate gas flow, the cable was designed to have the sheath a tight fit on the core and to have a central gas duct in the conductor. The use of a duct of purpose-designed dimensions, together with a dielectric of pre-impregnated paper, having little surplus compound, would also enable pre-determined uniform gas flow properties to be achieved.

As finally produced, the 0.35 sq. inch conductor consisted of a central spiral steel duct, over which were applied two layers of copper wires and a conducting screen of three impregnated metallised paper tapes. Pre-impregnated paper tapes were applied over the metallised paper screen to form the dielectric, which is itself screened with copper tape. The lead-alloy sheath, extruded to a shrink fit over this core, is reinforced against the internal gas pressure by three layers of tin coated bronze tape, all applied in the same direction. Between this tape and the jute yarn bedding for the armouring is a protective sheath of vulcanised rubber, capable of withstanding the highest lead sheath voltages liable to occur in service. The cable is armoured with a single layer of galvanised steel wire, applied in a direction opposite to that of the reinforcing tapes to balance torsional forces. The armour is served with two layers of compounded jute yarn and the cable has an overall diameter of approximately 4-in.

**Manufacture of the Cable.**

The design of cable adopted would have made it possible to manufacture the cable from stranding to coiling down in one continuous operation. There are, however, disadvantages to this, and it was decided to manufacture the cable in three distinct operations: stranding, insulating and lead sheathing and, finally, reinforcing, armouring and coiling down.

A special manufacturing company, British Insulated Callender's (Submarine Cables) Ltd., was formed, to manufacture cable by the above method for this and subsequent major submarine cable projects. A completely new cable factory unit was laid out at Trafford Park, Manchester, adjacent to the Manchester Ship Canal, possessing the advantage of deep-water berthing facilities. In-line production was most suitable for the manufacture of long, continuous lengths of cable and this necessitated not only many new items of plant but also the considerable modification of standard plant to adapt it for this specialised method of manufacture before being installed in the new unit.

Among the major items of specially built plant were two large turntables, to take the lengths of cable after each of the first two operations and then feed it to the succeeding operations, and a length storage mechanism. This latter item was necessitated by the desirability of having the insulating machine and lead press work in tandem. The pre-impregnated paper tape insulation was

## *Electricity for Vancouver Island—continued*

to be applied by a specially designed lapping machine, housed in an enclosure maintained at a constant, low humidity level. Special care had been taken in the building, equipping and testing of the lead press to ensure that it was capable of running for periods of up to twenty days without stopping, except for the few minutes necessary for recharging.

A large coiling-down shed, capable of taking the whole of the cable required for this contract, was constructed between the factory and the Trafford Wharf of Manchester Docks. A gantry, passing over the Trafford Park Road, carried the cable from the factory to the shed and an extension of it carried the cable on to the dockside, directly over the tanks of the cableship.

As has been already emphasised, in this design of submarine power cable the main effort had been to produce continuous lengths of cable that could be laid from shore to shore without joints. It was realised, however, that some unforeseen occurrence or damage in the factory or during laying might call for repair work and jointing on the cable. Provision had to be made for such a contingency. A factory joint, suitable for repair of cable damaged during manufacture, was designed and tested. Such a joint was used twice during the manufacture of one of the sixteen mile lengths of cable. This length was tested satisfactorily after manufacture and was later put into service without incident.

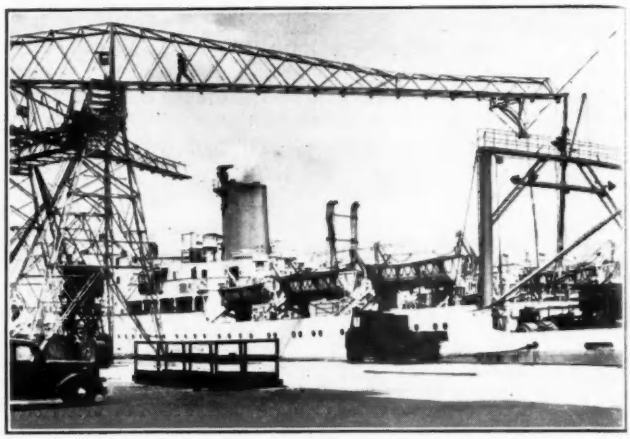
The possibility of damage occurring during or after installation also made it necessary to have available a joint which could be used to effect a repair of a finished cable. Such a joint must be capable of withstanding the mechanical stresses exerted on it during re-laying, in addition to the continuous electrical and pneumatic stresses imposed upon it in service. The actual jointing operation must be capable of being performed in the shortest possible time owing to possible weather hazards at the time of jointing. Considerable development work was carried out to evolve a satisfactory submarine joint. Joints of the final design were given prolonged mechanical and electrical stability and submersion tests and were found to be entirely adequate. A number of these joints were manufactured and delivered to Vancouver in time for the cable laying operations.

The contract required the cable system to be installed and in operation by the autumn of 1956. It was necessary that laying should take place in good weather and, as the laying would take about two months, the cable had to be on site by early Summer. To meet these requirements, comprehensive plans and rigid time schedules were drawn up well in advance. During 1954 detailed development work on the cable design and installation of the plant was carried out. Prototype lengths of cable were manufactured and subjected to full scale proving tests. Manufacture of the first commercial length commenced in March, 1955. From then onwards, work was continued twenty-four hours a day, seven days a week for the next twelve months, with breaks only for public holidays. The manufacture of the cable was completed in March, 1956, several weeks ahead of schedule and the ninety-one miles of finished cable stored in the coiling-down shed, awaiting transfer to the cableship.

**Loading and Transporting the Cable.**

While the manufacture was proceeding, careful consideration was being given to plans for loading, transport and laying of the cables. It was obvious that the laying of such long and heavy lengths of submarine cable required the use of a cableship. Very few cableships suitable for dealing with such a large volume and weight of power cable exist. For the extended period necessary due to the long journeys involved, the BIC Construction Company were able to charter the cableship "Ocean Layer," owned by Submarine Cables Ltd. This ship, of 4,600 tons—the second largest cableship in the world—was judged to be the most suitably equipped for the Vancouver undertaking.

Early in May, 1956, loading of the cables commenced at Trafford Wharf. It had been decided that the cables for the short crossing would be laid before those for the longer Georgia Strait. The order of manufacture and loading of the cable had therefore to be carefully planned in order to ensure correct maintenance of the ship's trim at all times, combined with correct order of availability of the cables on site. The 3,800 tons of cable to be taken in meant fully loading the ship. In order that the cable tanks

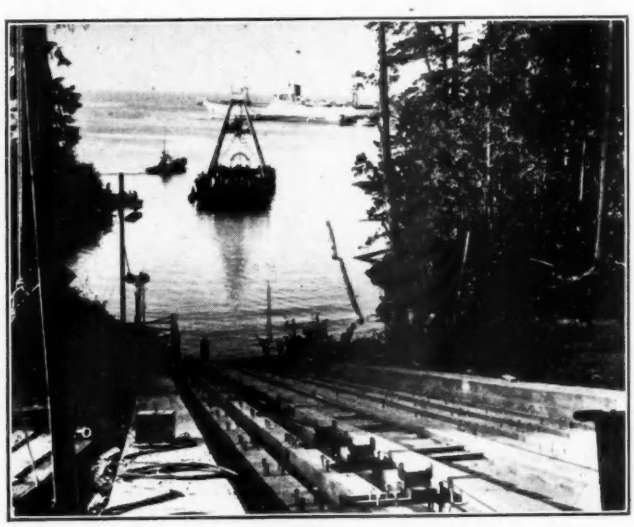


Lowering the cable by means of the cantilever loading beams into No. 4 cable tank of the C.S. "Ocean Layer" berthed at Trafford Wharf.

should be loaded to their ultimate capacity, the cable was loaded in layers by the "in and out" method, rather than the more normal but less compact "lay out" method of coiling from the circumference towards the centre adopted on Post Office cableships. Great care was taken in handling the cable and no difficulty was experienced, either in loading or unloading the tanks.

The scheme finally decided upon by the British Columbia Electric Company was for A.C. power at 60 c/s to be transformed from 230 kv. to 138 kv. at Arnott Sub-Station in the Delta area of the mainland of British Columbia. Thence, via an overhead route on wooden poles, the power would be carried to a point at Tsawwassen Beach, just west of Point Roberts. From here, there would be a submarine cable crossing across the Strait of Georgia to Galiano Island. An overhead line, on steel towers would then continue the transmission across Galiano Island, an intervening channel and Parker Island. There would then be a second submarine cable link to a point on Saltspring Island and finally an overhead line across the island and another channel to Vancouver Island, there to be linked, at Stratford Sub-Station, with the main Vancouver Island 132 kv. transmission system. In all, the length of line from Arnott to Stratford is approximately forty-eight miles

Thus it will be seen that two submarine cable crossings were necessary, the longer one, of approximately sixteen miles, crossing the Strait of Georgia from the mainland near Point Roberts to Galiano Island, and the shorter, of three miles, crossing Trincomali Channel from Parker Island to Saltspring Island. The other



A scow approaching the landing site at Galiano Island. In the background is the C.S. "Ocean Layer."

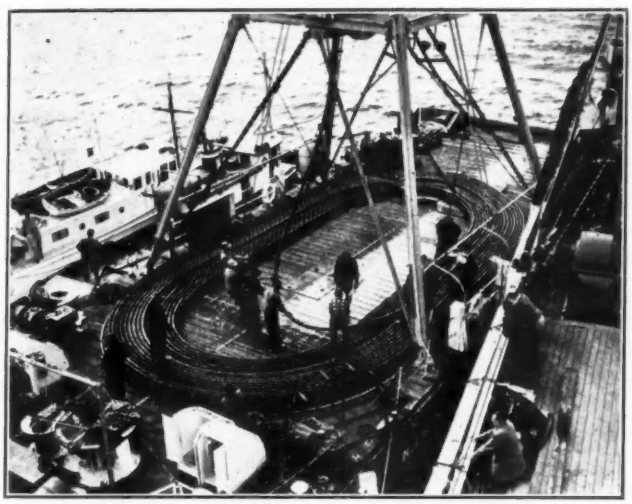
## *Electricity for Vancouver Island—continued*

water crossings incurred were quite short and were to consist of overhead spans of four-conductor lines.

The operating system envisaged at present is a single three-phase 138 kv. link. In the future, the Island's power demands may increase sufficiently to require the installation of a duplicate link. The ultimate provision of seven single-core cables has been anticipated, that is, two circuits and one spare cable. It was desirable that some spare cables should be provided for this initial circuit, so the order was placed for the installation of five cables across the Strait of Georgia and four across Trincomali Channel.

**Four Landing Points Selected.**

A detailed examination of the coastline and a hydrographic survey of the routes between possible landing positions were made for both crossings and, as a result of these, four landing points were selected. Conditions at Galiano, Parker and Saltspring Islands were all similar; steep, tree-lined rocky slopes to the shore, with good, deep water offshore. The landing points selected were small, natural coves giving the easiest possible land approaches. At these landing sites, concrete chases with provision for seven cables were constructed, from low water mark to near the entrance of the sealing end enclosures.



Cable for landing on Tsawwassen Beach being loaded on the deck of a scow from the cableship.

From Tsawwassen Beach, the ground rises steeply to a height of 180-ft. The cliff, consisting of loose, sandy soil lightly covered with vegetation, was known to be unstable, particularly when the vegetation had been removed. It was considered that there would be great difficulty in providing a sufficiently secure foundation for a concrete chase as used at the other landing sites. Instead, a concrete surface cable tunnel, 500-ft. long was erected down the face of the cliff. The approach to the beach from the water was also more difficult here than at the other sites as there were mudflats, exposed at low water, for a mile and a half off-shore. Beyond that, the water increased in depth steadily to a maximum of just over 100 fathoms.

In order to facilitate subsequent identification and, if necessary, recovery for repair, it was planned that the cables of the main crossing should have a spacing of approximately 500 yards and of the shorter crossing a spacing of 250 yards. In view of the probable future additions, the cable positions were planned on a basis of seven cables per crossing. This wide spacing for so many cables made it necessary for there to be considerable differences in length between cables for the same crossing, thus adding considerable complications to the planning and to the actual operation.

Careful attention had to be given to the problem of exactly how the cable should be laid. Cable laying of this kind resolves itself into two distinct parts: laying across the central channel and landing the shore ends. Laying across the channel is carried out by paying the cable out from the moving ship. This is of course a normal function of cable laying ships and this part did not, in fact, present any great difficulties. It was desired that the cable should lie straight on the sea bed, without appreciable tension, yet without loops, and a method of laying was evolved whereby the tension was applied to the cable according to a previously calculated schedule depending on the depth at the point of laying. This schedule was based on a nominal laying speed of three knots.

For the laying of the shore ends it is necessary for the ship to be stationary and to have some arrangement for landing the cable ends. The three landing sites at Galiano, Parker and Saltspring Islands presented no great difficulties, as the ship could approach quite close to the shore and the cable ends could be taken ashore supported on barrels. The shore at Tswwassen Beach was very different, being similar to that on the French coast from Calais to Cap Gris Nez, and difficulties in landing the shore end were expected. The extremely shallow water so far off shore meant that an alternative method to barrelling had to be found. It was decided to coil the requisite amount of cable, about 3,000 yards, on to the deck of a flat-bottomed vessel of very shallow draught (often referred to as a " scow ") and to lay cable while towing this inshore. When close in, the vessel would be moored and the end pulled ashore. Suitable scows were known to be available in the Vancouver area, but would have to be fitted with the necessary equipment: winches for mooring and cable and scow handling, cable brakes, fair leads and other apparatus to ensure that the cable would at no time suffer undue stresses. The equipment required for the cable handling was designed and produced in the autumn of 1955 and tried out on land. In November of the same year, the equipment, mounted on a scow, and the " Ocean Layer " were employed in cable laying and recovery trials off Falmouth. These trials confirmed that the scow method of landing shore ends was satisfactory and it was adopted on the Vancouver contract, two complete sets of scow equipment being sent out from England to Vancouver early in 1956. The scows could also be used at the other landing sites, and so it was decided to use two scows, one for all the starting ends of the cables and the other for all the finishing ends.

During the period that the cableship was on her way to Vancouver, via the Panama Canal, all the scow equipment was assembled and tried out at Vancouver, and the staff, which had been sent out from England, were finally briefed. It was a point of great satisfaction to those responsible for the design and operation of the specialised plant that, during the actual laying, the operations proceeded as originally planned and without modification or alteration.

The " Ocean Layer," after her 8,700 mile trip from England, reached Vancouver City in early July. To enable the team to gain experience on the easier operation, it was decided to lay the shorter cables crossing the Trincomali Channel first, before attempting the longer Strait of Georgia crossing and the more difficult landing at Tsawwassen Beach.

**Laying of the Cable.**

Cable laying was commenced on the 18th July and was continued throughout the following four weeks. For the whole of this period the weather was favourable, the long spell of fine weather being remarkable even for Vancouver at this time of the year. One factor which had to be learnt and taken into account was the unusual tidal behaviour. A double tide could result, with unusual shore currents; the period of high tide was generally longer than that of low tide during the cable laying and, at times there was no period of slack water.

The laying of the first cables was carried out with day intervals to rest the crews. During the laying of the third short length, as the ship was nearing the buoys off Parker Island, the cable was damaged by excessive pressure on the ship's bow sheave housing. The cable broke down under test and plans were made for repairing the damage after the longer lengths had been laid across the Strait of Georgia.

After laying the fourth short length, the cableship and the two scows moved into Georgia Strait to lay the five sixteen-mile lengths. Two days had been allocated for laying each cable. Once work had started, it went through smoothly, all five cables being laid

## *Electricity for Vancouver Island—continued*

within the scheduled ten days. A mile off Galiano Island, the sea bed rises rapidly from 100 fathoms to only forty fathoms, but this did not cause any difficulty. While the laying was in progress, work was proceeding on the shore ends.

The cableship and attendant scows then returned to Trincomali Channel to repair the faulty cable. Six hundred yards of new cable was coiled on the deck of a scow. The shore end of the cable was picked up as far as the fault, from a depth of twenty-five fathoms, and laid on the deck of the scow without difficulty, using its own equipment. The main length of cable was then jointed, on the scow, to the new length of cable, the joint lowered overboard and the new cable end taken ashore. The whole of this operation of picking up the cable, cutting out the fault, jointing and re-laying the cable took less than three days.

Immediately after each cable had been laid, a high voltage D.C. test was carried out on the cable at atmospheric pressure. The cables were then moved into their final positions in the chases and the ends terminated in sealing ends. They were next gassed and the official high voltage acceptance test carried out, together with other electrical tests and a pneumatic test to ensure gas tightness. To prevent damage to the cables, malleable iron protectors were fitted to the cable at the shore end of the concrete chases to below low water mark at the three deep water landings. At the Tsawwassen Beach landing, the protectors were fitted for a short distance from the tunnel entrance, the remainder of the shoreward end of the cable being buried in trenches.

All the cables were made alive in turn, the first trial transmission of power to Vancouver Island taking place in late August.

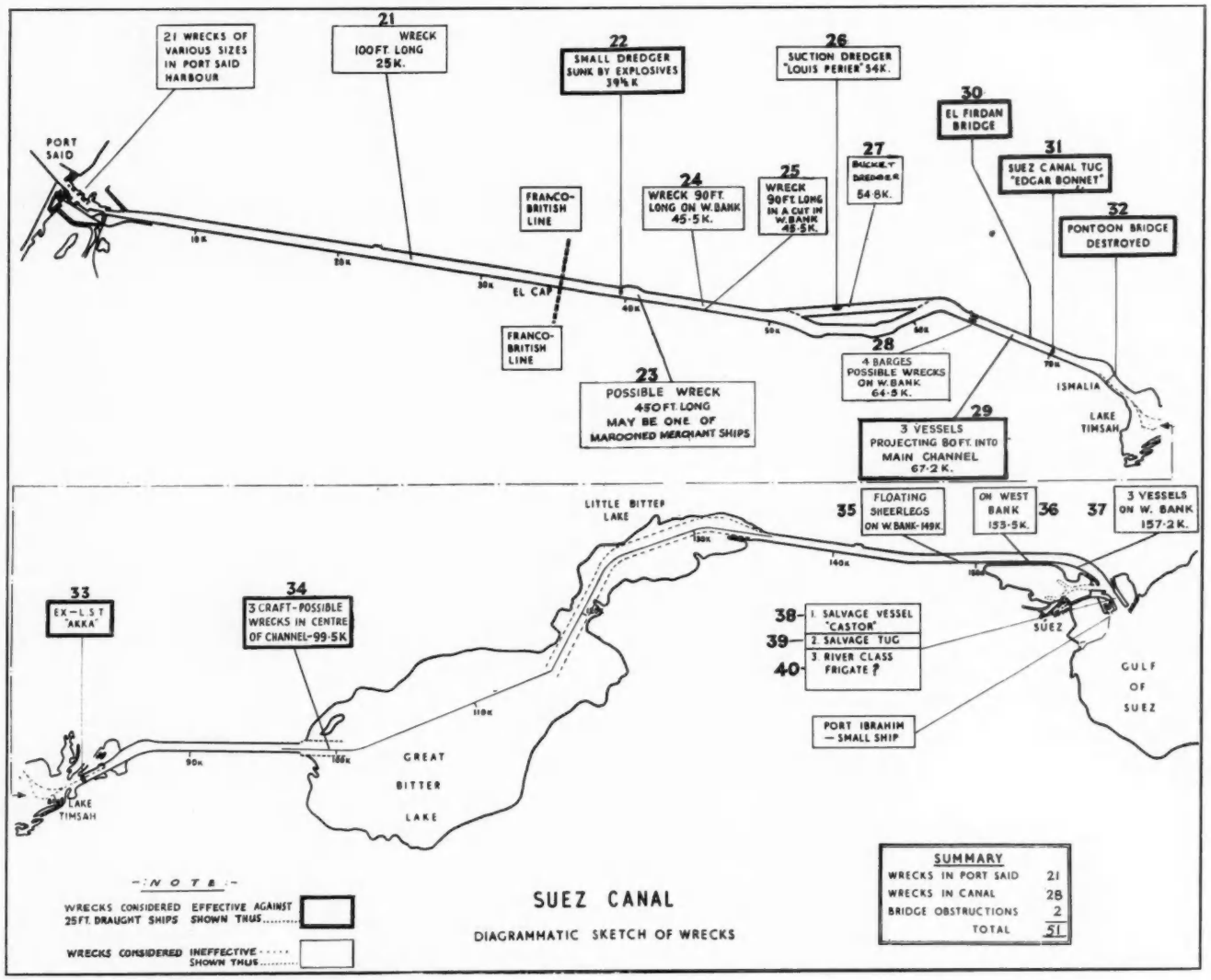
# Clearing the Suez Canal

### Impressive Fleet of Salvage Vessels Available

The delay in re-opening the Suez Canal to international shipping is causing anxiety throughout Western Europe, and the economies of many countries are being seriously affected. Apparently, however, political considerations are still hampering a decision as to when the work of clearing obstructions shall be started and by whom it shall be undertaken. Confidence that the Canal could be cleared with the least possible delay was expressed by Mr. Selywn Lloyd in the course of his statement on the Middle East to the House of Commons early this month. He stated that he had made it clear to the Secretary-General of the United Nations that all resources assembled by Great Britain in the area would be available to the United Nations forces to use as and how they may decide. In this connection an announcement has been issued by the Admiralty which gives a clearer picture of the problem involved in re-opening the Suez Canal and assesses the suitability of the forces gathered together for accomplishing the task.

There are 51 obstructions to be cleared away before the canal is fully restored to its normal state and there may be more beneath the surface of the water which have not yet been located. Mines have also been laid at the Suez end. In order that ships of limited size can begin using the canal again without waiting for complete clearance of the waterway it is evident that the operations should proceed in three stages.

The first stage involves the clearance of a through-channel suit-


21 WRECKS OF VARIOUS SIZES IN PORT SAID HARBOUR
21 WRECK 100 FT. LONG 25K.
22 SMALL DREDGER SUNK BY EXPLOSIVES 39¼K
26 SUCTION DREDGER "LOUIS PERIER" 54K.
30 EL FIRDAN BRIDGE
31 SUEZ CANAL TUG "EDGAR BONNET"
27 BUCKET DREDGER 54·8K.
24 WRECK 90 FT. LONG ON W. BANK 45·5K.
25 WRECK 90 FT. LONG IN A CUT IN W. BANK 48·5K.
FRANCO-BRITISH LINE
32 PONTOON BRIDGE DESTROYED
PORT SAID
EL CAP
FRANCO-BRITISH LINE
23 POSSIBLE WRECK 450 FT. LONG MAY BE ONE OF MAROONED MERCHANT SHIPS
28 4 BARGES POSSIBLE WRECKS ON W. BANK 64·5K.
29 3 VESSELS PROJECTING 80 FT. INTO MAIN CHANNEL 67·2K.
ISMALIA
LAKE TIMSAH
LITTLE BITTER LAKE
35 FLOATING SHEERLEGS ON W. BANK 149K.
ON WEST BANK 153·5K.
36
37 3 VESSELS ON W. BANK 157·2K.
33 EX-L.S.T. "AKKA"
34 3 CRAFT-POSSIBLE WRECKS IN CENTRE OF CHANNEL-99·5K
38 1. SALVAGE VESSEL "CASTOR"
39 2. SALVAGE TUG
40 3. RIVER CLASS FRIGATE?
SUEZ
GULF OF SUEZ
PORT IBRAHIM — SMALL SHIP
GREAT BITTER LAKE
LAKE TIMSAH
SUMMARY
WRECKS IN PORT SAID 21
WRECKS IN CANAL 28
BRIDGE OBSTRUCTIONS 2
TOTAL 51
-NOTE-
WRECKS CONSIDERED EFFECTIVE AGAINST 25FT. DRAUGHT SHIPS SHOWN THUS
WRECKS CONSIDERED INEFFECTIVE SHOWN THUS
SUEZ CANAL
DIAGRAMMATIC SKETCH OF WRECKS

## *Clearing the Suez Canal—continued*

able for ships of 25-ft. draft and at least 60-ft. beam, similar to that already achieved at Port Said. This will involve the shifting of nine wrecks and two bridges out of the channel, all of which are in Egyptian-controlled territory.

Stage two is the clearance of the remaining wrecks from the channel to enable complete freedom of navigation, and stage three is the removal of the debris from the berths, general tidying up and dispersal of the wrecks from the canal altogether.

The accomplishment of the first stage is obviously the one requiring the utmost urgency so that trade may again flow, although on a reduced scale until the second stage can be completed. The object must be to open the channel quickly without necessarily removing the wrecks right off the scene. If they cannot be completely removed quickly they must be lifted to the side of the channel or slewed parallel to the canal banks.

In other cases, where the weight of the ship is too great for lifting craft, buoyancy may have to be restored by patching, cofferdamming and pumping, or by the use of compressed air. The "Paul Solente" (3,700 tons) at Port Said, with eight holes blown in her bottom, may have to be dealt with in this manner.

The best method for the removal of a particular wreck will have to be decided after a survey has been carried out upon it. The most suitable salvage craft or a combination of craft can then be allocated for the job. For example, the 115-ton tug "Actif," sunk at Port Said, could be lifted directly from the bottom by one coastal salvage vessel.

The coastal salvage vessel is an ideal ship for the operations envisaged in the first stage. Equipped with horns and heavy rollers, it can lift 200 tons deadweight over the bow, has shallow draft and can "sit on the bottom," if required. These ships were evolved for the naval service as a result of experienced gained in quick clearance of blocked harbours during the last war, when they did excellent work in Northern Europe.

They are vessels designed for war where the quick removal of blocks, to form an effective channel into a captured port, may well decide the outcome of land operations. This type of ship is not built for commercial purposes, where the market demands ships for deep-sea salvage rather than those equipped for heavy lifts in shallow water. Coastal salvage vessels are therefore only obtainable from Admiralty sources. Seven of them will be at Port Said early this month with two more at the end of the month.

British naval lifting craft are of three types—1,200, 750 and 600 tons each. They work in pairs and are operated by passing 9-in. wires under the wreck, which are then secured to the lifting craft on each side. The lifting craft are flooded down by filling their tanks with water. The wires are secured taut and the tanks are then pumped out at low water. This supports the wreck in the bight of the wires and as the tide rises it is lifted off the bottom and can be towed away. If there is no tidal rise, wrecks of reduced weight can be lifted using the buoyancy of the lifting craft alone.

As well as numerous salvage pontoons and tugs, other British craft of the following types will be in Port Said early this month:—

Ocean salvage vessels completely self-contained for long periods with stores, pumps, air compressors, workshops and much other salvage equipment. They form an essential part of a balanced salvage force in the canal for dealing with wrecks such as the "Paul Solente." Two are in Port Said and another will arrive within a week. One will reach Aden early this month.

Boom defence vessels are normally employed on the laying and maintenance of boom defences and on mooring work. When supplied with suitable equipment they can, however, be employed as miniature coastal salvage vessels with a 70-ton lift. They are particularly useful for laying out ground tackle for salvage operations. Seven of them will shortly reach Port Said and another four will be at Aden ready to start work on the southern end of the canal.

Other vessels include wreck dispersal ships, which carry large quantities of depth charges and other explosives for blowing down a wreck in order to give an adequate depth of water for safe navigation and survey vessels invaluable in surveying wrecks, marking channels and taking soundings. One wreck dispersal vessel will shortly reach Port Said; one survey vessel is already there.

The Admiralty Statement concludes by saying that such an extensive salvage fleet of 35 British ships forms a well-balanced and unique force, equipped and ready to carry out the task. Less than a quarter of this force has already opened Port Said and unbarred the way to the sea for some of the ships in the convoy, trapped in the Canal. If the channel is to be cleared throughout in the minimum time, it is certain that extraordinary forces such as this must be deployed rapidly to get to work upon the 11 blocks which are effectively obstructing the channel.

**Clearance Work in Port Said.**

As far as the progress of the clearance being undertaken by the French and English salvage fleet is concerned, this is proceeding satisfactorily. Two Admiralty lifting craft raised a 11,000 ton mud hopper and French salvage craft partially raised a 5,000 ton floating dock on the 6th of this month. A 350-ton barge has also been lifted and beached. A 500 ton tug, which sunk in the above-mentioned floating dock is now in process of being lifted.

Another operation which has progressed favourably has been the cutting out of the 36 heavy iron buckets from a scuttled dredger, preparatory to righting and lifting the dredger which is on its side.

Other wrecks being worked on at the time of going to press are the hopper "Neptune," 1,500 tons; the tug "Hercule," 1,200 tons; and the tug Gar, 235 tons. More difficult and longer work will be needed on the £1 million suction dredger "Paul Solente," and a large floating crane of a total weight of 1,700 tons.

Salvage work could be considerably speeded up following the arrival of the two German lifting craft "Ausdauer" and "Energie" in Port Said. Also Danish and Dutch salvage vessels are available to take part in the work.

## Improvement Schemes for Newport and Barry Docks

The British Transport Commission have approved the provision of additional port facilities costing £1,365,000 at Newport and Barry Docks, South Wales.

**Port of Newport.**

The works at Newport will involve the expenditure of £1,100,000 on the provision of transit sheds, of quay cranes and other mechanical equipment, and on improved road and rail access. These works will comprise:—

**South Quay, South Dock.** The layout of this quay is to be improved and a single-storey transit shed, 600-ft. long and 100-ft. wide, will be constructed. The shed will be equipped with two overhead gantry cranes, and mobile cranes, fork-lift trucks, and electric trucks will be provided. Twenty electric level luffing quay cranes, of 6 tons lifting capacity, with a working radius of 70-ft. and capable of dealing with the many cargo liner vessels which regularly trade to the port, will be installed. Access to the quay by rail and road vehicles will be re-modelled so as to eliminate the existing level crossings and the road will be widened to 35-ft.

**North Quay, North Dock.** The hydraulic cranes now at this quay, which is used by smaller classes of vessels, will be replaced by electric cranes displaced from the South Quay. A single-storey transit shed, 220-ft. long and 75-ft. wide, equipped with mobile mechanical cargo-handling equipment, will be constructed for the reception of import and export traffic.

**Port of Barry.**

A new berth, costing £265,000, is to be provided at Barry for vessels laden with bulk dry cargoes such as imported coal, scrap iron and steel, ores and chemicals.

The new berth will be on the North Side of No. 2 Dock and will be 570-ft. long. It will be equipped with five electric quay cranes of 10 tons lifting capacity and specially designed for grab work. The cranes will have a radius of 70-ft. and will be able to load into railway trucks on five lines to be installed on the quay, the surface of which will be flushed in concrete to provide easy access for road vehicles.

# Personalia

## The Institution of Structural Engineers
## Mr. J. Guthrie Brown—President 1956-7

John Guthrie Brown was born in Uddingston, near Glasgow, and upon leaving school, proceeded to the Royal Technical College, Glasgow, for further training. He received his practical experience in engineering as a pupil with Formans & McColl, Glasgow, one of the famous consulting firms of the railway era, and spent his early years on railway, structural and dock and harbour works. In 1926 he become deputy Chief Engineer to his present firm, Sir Alexander Gibb and Partners, London. Ten years later he was appointed Chief Engineer and in 1938 became a Partner in the firm. He is now a Senior Partner.

Mr. J. GUTHRIE BROWN, M.I.C.E., M.I.Struct.E., M.I.E.Aust., M.N.Z.I.E.

Mr. Guthrie Brown is a Member of the Institution of Civil Engineers, a Member of the Institution of Engineers (Australia) and a Member of the New Zealand Institution of Engineers. He is also a Member of the Institution of Structural Engineers and was recently elected President of that body for the 1956—1957 Session. He is a member of Panel 1 of Engineers qualified under the Reservoirs Act, 1930, to deal with the design, supervision and inspection of large dams in the country and is Chairman of the British National Committee of the International Commission on Large Dams and a member of the British Section of the World Power Conference.

Among the many major works for which Mr. Guthrie Brown has been responsible, on behalf of his firm, is the Kincardine-on-Forth Bridge in Scotland. This road-bridge is over half a mile in length and has the largest swing span in Europe, with a length of 364-ft. and a moving weight of 1,600 tons. Included in his diverse activities during the Second World War was the design of the Captain Cook Graving Dock in Sydney Harbour. This, one of the largest graving docks in the world, was undertaken by the Commonwealth Government of Australia to provide docking facilities for the largest ships of the British Navy and also for commercial ships. It was completed early in 1945.

Mr. Guthrie Brown has been concerned with various types of structural engineering, and more particularly with hydro-electric developments, including the design of the Galloway Water Power Development in South-West Scotland, from its inception in 1928. Since then, he has dealt with hydro-electric projects in many parts of the world.

For the past thirty years, Mr. Guthrie Brown has been connected with the various developments which have taken place in the Port of Rangoon. This work included the Rangoon Tidal Model, which was constructed in the United Kingdom to study the various problems connected with the maintenance of the navigable channels from the Gulf of Martaban to Rangoon 25 miles up the river. He also is concerned with the developments of the naval base now being undertaken at Bombay, and with extensions to several dry docks in Great Britain. He is also advising the Dublin Dock Board in connection with the construction of a new dry dock.

# An Articulated Factory Building

## A New Approach to Subsidence Problems

A new factory, the second to be completed at Peterlee New Town, has been built to the order of North Eastern Trading Estates Ltd. It stands on a site of approximately 2¾ acres, the buildings occupying nearly 48,000 sq. ft., of which about 8,000 sq. ft. comprise offices, boiler house and other ancillary buildings.

The main factory building has a floor area of about 40,000 sq. ft. and is of interest, not only as a further stage in the development of this satellite town, but chiefly because it brings a completely new approach to the problems of mining subsidence.

Complex coal workings were started under the site in 1946, and it was predicted by the mining engineers and consultants that vertical differential subsidence of about 9-in. could be expected which, combined with ground surface zones of compression and tension at varying times, would give rise to differential settlement of any one part of the building relative to any other part.

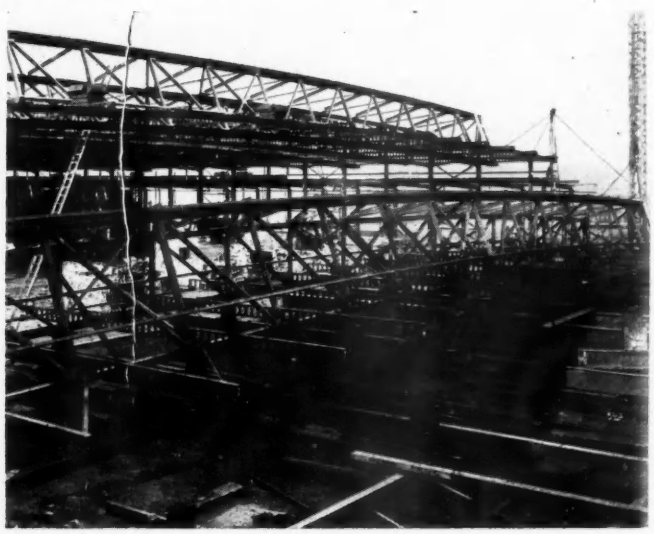
Somewhat similar unsatisfactory foundation conditions, of course, often occur at building sites elsewhere and perhaps most usually in the environment of docks and harbours, where the ground is often alluvium of treacherous character and in many cases has been reclaimed. The deleterious effects of settlement inherent in bad ground may be overcome in some instances by piling or, where a solid stratum does not exist within a reasonable depth, by the construction of raft foundations. Neither of these methods was feasible at Peterlee.

The problem, therefore, was to produce the necessary freedom of movement within the building structure to permit any part to subside without overstressing the steel structure or damaging the cladding.

The method adopted at Peterlee and, of course, applicable to a variety of other conditions, consisted of two essential features.

Firstly, the length of the building was divided into small units, each complete in itself and structurally independent of the rest, thus localising the effect of differential settlement to a very small length of building. The second step was to introduce hinges into each unit so that one side of the building could subside relative to the other side, causing the building to tilt across its width, without seriously affecting the structure or cladding. This was resolved by the architects and the consulting engineer by adopting one single wide span, without internal stanchions, on the basic principle that the effect of a given displacement would be less over a long span than over a short one, since the angle of displacement must be less.

This resulted in the main factory building being 120-ft. wide by 330-ft. long by 16-ft. high, made up of thirteen units, each 120-ft.



Roof unit 120-ft. long by 25-ft. wide assembled on the ground and ready for lifting into position.

## *An Articulated Factory Building—continued*

wide by 25-ft. long. This gives a clear factory floor area of about 40,000 sq. ft., which is not in itself remarkable, except that any of the thirteen units could subside without seriously affecting the building, and any number of units could be added to give a building of any required length.

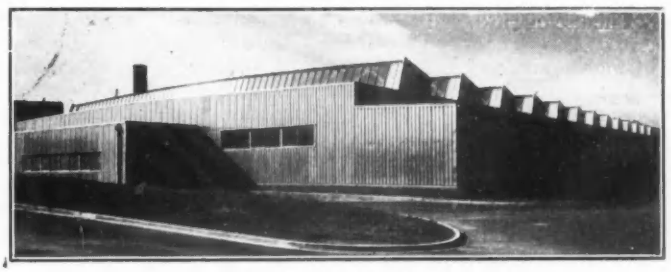
Each unit is a structural steel frame of all-welded construction, comprising four stanchions, two at each side, and two lattice girders 120-ft. long. Each pair of stanchions is braced together at 8-ft. 4-in. apart and is hinged at the base. The lattice girders form the sides of the monitor roof lights, one vertical the other sloping, and are rigidly connected to the pair of stanchions at one end. The other ends are hinged at the stanchion caps, so that when subsidence occurs, the 25-ft. wide strip of roof rotates slightly across the building to accommodate the movement of the stanchions.

The roof is a steel deck with thermal insulation and is carried on castellated beams running across the bottoms of the roof girders to cantilever on either side. The roof girders have a rise of 18-in. at the centre and the deck beams follow this curve to give the necessary drainage slope to the roof deck.

To maintain the structural independence of each unit, the tops of the girders are braced together, while the bottoms are braced with a horizontal girder in conjunction with the deck beams, clear of the monitor roof lights.

The side cladding is of aluminium with thermal insulation, supported on steel framing which cantilevers across the pair of stanchions.

Very careful consideration was given to the design of the cladding and the floors to ensure that damage would not arise from



View of the completed building.

movement of the structural frame. Another important point is the junction of the units with each other, and it was decided to form a 2-in. wide gap between each unit for the full height and width, so that the only connection between the units is a flexible flashing to weather the gap while permitting a reasonable amount of differential movement.

Provision has been made for jacking-up the stanchions should the settlement approach the predicted figures, and all the anchor bolts have long extensions with sleeves so that the concrete foundations can be built up.

The architect for the scheme was J. H. Napper, M.A., F.R.I.B.A., A.M.T.P.I., and the consulting engineer D. W. Cooper, B.Sc., A.M.I.Struct.E. The contractors were Messrs. Bovis Ltd.

All the steelwork was fabricated and erected by Palmers Hebburn Works, of Vickers-Armstrongs (Shipbuilders).

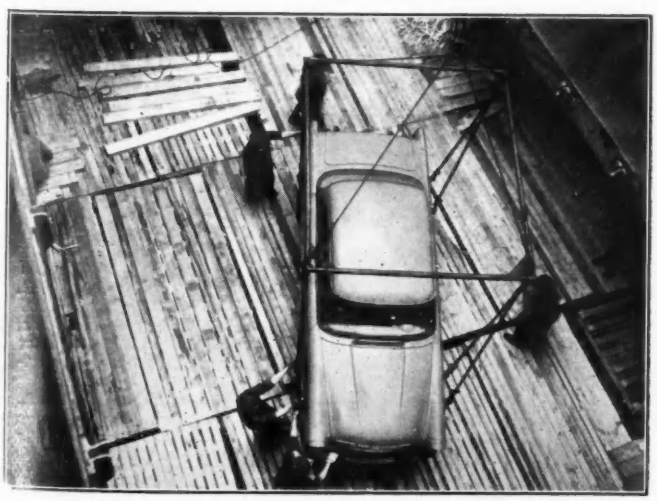
# Manufacturers' Announcements

### Crating Cars for Export

The efforts of the British motor industry to overcome the difficulties of finding adequate cargo space to ship their ever increasing export orders has resulted in a new technique which has been evolved by the Ford Motor Company Ltd. of Dagenham.

The method adopted is to put the cars into skeleton crates with boarded-in tops, so that other loaded crates can be stacked on top of the previous layer. Finally the last layer, which usually consists of smaller cars can be parked and secured uncrated on the false "floor" formed from the crates already stowed. In this way several layers of cars can be loaded into the hold of a ship which would normally hold only one level of uncrated cars.

The crates are open sided and are bolted together with 3½-in. and 4½-in. carriage bolts. Those for the smaller varieties of car are made with a main frame of 3-in. x 2-in. timber and 4-in. x 1-in. diagonal struts. The top is of ¾-in. boarding reinforced with transverse boards. The crates for the heavier cars have 4-in. x 2-in. side rails for greater strength and the floor is reinforced. The weight of the car is taken on the front chassis cross-member and the rear spring clip plate assemblies, the wheels rest in cradles secured to the lower side rails. As the bumpers are removed for shipping, brackets are bolted from the vacated bolt-holes to a transverse member at each end of the crate.



A car being wheeled across the floor artificially created by crated cars stacked two-high in the hold of a ship.

### St. Lawrence Seaway Contract

Russell Construction Ltd. of Toronto, a wholly owned subsidiary company of Balfour, Beatty & Co., Limited, London, has been awarded a contract valued at $7,280,000 (£2,570,000) by the St. Lawrence Seaway Authority in connection with dredging in the Welland Ship Canal which joins Lake Erie and Lake Ontario.

This is the first major contract for work on the St. Lawrence Seaway awarded to a British firm. The contract was signed in Montreal on 20th November by Sir Andrew M. MacTaggart, Chairman of Balfour, Beatty & Co., Limited, and by the President of the Canadian subsidiary.

The contract consists of drilling and blasting rock to deepen the canal in preparation for the larger ships passing through when the Seaway is complete. There is also excavation in soft by suction dredging. All work has to be carried out in such a way as not to interfere with normal shipping. The contract is due for completion by 30th September, 1958.

### Hexmetal Industrial Flooring

In the Fifteenth Century the monks of Bealieu Abbey constructed a floor of ceramics fitted into an iron hexagonal honeycomb reinforcement. Now a British Company is marketing the modern development of this old principle under the name of "Hexmetal."

Manufactured by Causeway Reinforcement Ltd., Victoria Street, London, Hexmetal is a fabrication of steel-walled honeycomb cells, which when loaded with a filler, acts both as a binder and as a separator. It absorbs impact load and vibrations, and inhibits cracking caused by corrosive spillage. The properties of Hexmetal make it ideally suited for floor installation, and for surfacing of loading bays and roads which are subject to excessive load or vibration. The surfaces are non-slip by virtue of the alternating surface tensions of steel and cement. A recent example is the surfacing of caissons at H.M. Dockyard at Portsmouth.

## *Manufacturers' Announcements—continued*

The use of Hexmetal represents a considerable saving in installation costs. A floor subject to heavy impact load needs to be made of high grade concrete to a depth of 4-in.. to 6-in. When Hexmetal is imbedded, however, the filler of high grade concrete required is only 1-in.—1¾-in. on a foundation of inferior mix. When laying, the concrete should be levelled off at 1-in. below the required surface and allowed to set off. The mats of Hexmetal are then put into position and filled. The filler concrete is made up as a stiff mix, without slump and slurry, to provide an adament surface. The work can be done in sections, as and when conditions permit. Cell loading materials may be common concrete, granolithic, asphalt or any other type of media, depending on the loading and corrosion problems involved.

### Arpic International Photograph Competition

In the December, 1955, issue of this Journal, Messrs. Arpic Engineering Ltd. announced in their advertisement an international photograph contest. Prizes were to be awarded for the best colour and the best black and white print of an Arpic Air Compressor at work in interesting surroundings. The entries have now been judged and the prize-winners are as under:—

COLOUR PICTURES:

1st Prize: C. A. Fogden, Sulaimaniysh, Northern Iraq.
2nd Prize: J. Hunt, Wembley.
3rd Prize: E. W. Fellingham, Sulaimaniysh, Northern Iraq.
4th Prize: F. L. Graham, Taupiri, N.I. New Zealand.

BLACK AND WHITE PICTURES:

1st Prize: R. V. Francis Smith, Christchurch, New Zealand.
2nd Prize: C. Brock, Dudley, Worcestershire.
3rd Prize: C. Connell, Edinburgh.
4th Prize: J. Hunt, Wembley.
5th Prize: J. Bugejh, Zurrieq, Malta.

It is to be noted that the Arpic Engineering Ltd. have now merged with Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middlesex.

### Change of Names

Mr. G. A. Maunsell, M.I.C.E., who was formerly a partner in the firm of Maunsell, Posford & Pavry, which was dissolved in October, 1955, has since been and is now practising as a Consulting Civil Engineer in partnership with Messrs. J. W. Baxter, E. M. Birkett, L. M. Rammage and P. F. Stott, A.M.M.I.C.E., under the title of G. Maunsell & Partners at 7, Cleveland Row, St. James's, London, S.W.1. Telephone: Trafalgar 1788.

The firm of Maunsell, Posford & Pavry, Consulting Engineers, is continuing its practice under the name Posford, Pavry & Partners. The address at Abbey House, Victoria Street, Westminster, S.W.1, and telephone number ABBey 2115 are unchanged.

## APPOINTMENTS VACANT

BOMBAY (India) Firm of Civil Engineering Contractors (Danish controlled) require urgently Civil Engineer for post of Deputy Engineer-Agent on their contract for construction of a graving dock in Bombay.
Qualifications required: Civil Engineering degree, practical experience in execution of heavy civil engineering jobs especially maritime structures and harbour works.
Age 30-40 years knowledge of French language required. Remuneration depending on qualifications and experience—salary in the region of £2,000 to £4,000 per annum with bonus terms. Assistance with living accommodation. Employment in the first instance on a contract for 3 years. For the right man also possibility of permanent position with the firm.
Write with full particulars, giving at least two references, to Box No. 195, "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

PORT OF BOSTON AUTHORITY
APPOINTMENT OF DOCK AND HARBOUR MASTER

APPLICATIONS are invited for the above appointment at a salary within A.P.T. Grade IV (£727 15s. rising to £907 2s. 6d. per annum) of the National Scales of Salaries, according to qualifications and experience.
Candidates should hold a Master's Certificate (Foreign-Going) and have had a watch-keeping experience in foreign-going ships.
Housing accommodation will be provided by the Authority, if required.
Forms of application and conditions of service, including a list of the duties to be performed, may be obtained from the undersigned, by whom applications on the form provided, in envelopes endorsed "Staff—Port Authority," must be received by the 22nd December, 1956.

Municipal Buildings, BOSTON, Lincs.

G. L. HOFFROCK GRIFFITHS,
Clerk to the Port Authority.

## TENDERS

COMMISSIONERS FOR THE PORT OF CALCUTTA
DREDGING WORKS AT KING GEORGE'S DOCK IN CONNECTION WITH RECONTRUCTION OF B, C AND D BERTHS

Tenders are invited from suitable Contractors for dredging in King George's Dock Basin, Calcutta, comprising the deepening of the dock basin, its extension for the formation of new quays, and the utilization of the spoil for reclaiming low lying land approximately 5,000 feet away. The approximate total quantity of material involved is 1 million cubic yards.
Drawings, Conditions of Contract and Specification may be obtained from either the Chief Engineer, Commissioners for the Port of Calcutta, 15 Strand Road, Calcutta, India, upon payment of a tender fee of Rs. 50 or from the Commissioners' Consulting Engineers and London Agents, Messrs. Rendel, Palmer and Tritton, 125 Victoria Street, Westminster, London, S.W.1, upon payment of a fee of £1 10s. Such tender fee will not be refundable.
Applications from Agents or other intermediaries will not be considered.
Tenderers are required, before submitting their tenders, to deposit as earnest money Rs. 20,000 or £1,500 sterling and a receipt for this amount must accompany the tender. Such earnest money is returnable to unsuccessful tenderers on application.
Tenders shall be submitted in triplicate; two copies to Messrs. Rendel, Palmer and Tritton at 125 Victoria Street, Westminster, London, S.W.1 so as to reach them not later than 10.30 hours G.M.T. on 31st January 1957, and one copy to the Chief Engineer, Commissioners for the Port of Calcutta, 15 Strand Road, Calcutta, India, by 16.00 I.S.T. on the same date.
The Commissioners do not bind themselves to accept the lowest or any tender, and reserve the right to reject a tender without assigning any reason.

(Sgd.) T. M. MALKANI,
Chief Engineer,
COMMISSIONERS FOR THE PORT OF CALCUTTA

RIVER HOOGHLEY TRAINING WORKS

Tenders are invited from suitable Contractors for RIVER TRAINING WORKS AT FULTA POINT, comprising the removal of a protrusion of the left bank of the River Hooghly by means of dredging and/or land excavation, and disposal of the spoil in adjacent land dumping areas and river dumping areas between Fulta Point and Luff Point; also dredging the river bed at specified places. The appropriate total quantity of material to be removed is 6.5 million cu. yds.
Drawings, Conditions of Contract and Specification may be obtained from either the Chief Engineer, Commissioners for the Port of Calcutta, 15 Strand Road, Calcutta, India, upon payment of a tender fee of Rs. 20 or from the Commissioners' Consulting Engineers and London Agents, Messrs. Rendel, Palmer and Tritton, 125 Victoria Street, Westminster, London, S.W.1, upon payment of a fee of £1 10s. Such tender fee will not be refundable.
Applications from Agents or other intermediaries will not be considered.
Tenderers are required, before submitting their tenders, to deposit as earnest money Rs. 25,000 or £2,000 sterling and a receipt for this amount must accompany the tender. Such earnest money is returnable to unsuccessful tenderers on application.
Tenders shall be submitted in triplicate; two copies to Messrs. Rendel, Palmer and Tritton at 125 Victoria Street, Westminster, London, S.W.1, so as to reach them not later than 10.30 hours G.M.T. on 4th February 1957 and one copy to the Chief Engineer, Commissioners for the Port of Calcutta, 15 Strand Road, Calcutta, India, by 16.00 hours I.S.T. on the same date.
The Commissioners do not bind themselves to accept the lowest or any tender, and reserve the right to reject a tender without assigning any reasons.

(Sgd.) T. M. MALKANI,
Chief Engineer,
CALCUTTA PORT COMMISSIONERS.

**FOR SALE**

STATIONARY STEAMDRIVEN BARGE UNLOADING RECLAMATION DREDGER. Built Lübeck 1912. In perfect condition. Hull: 121-ft. 5-in. x 31-ft. 6-in. x 12-ft. 11-in. Suction delivery. 26-in. $\phi$ Sandpump driven by Triple Expanding Engine, 960 i.h.p. 150 r.p.m. Waterpump driven by Triple Expanding Engine, 280 i.h.p. Two boilers each 1971/2185 sq. ft. H.S., Pressure 185 lbs./sq. in. Oilburning outfit available but not installed.

**FOR CHARTER**

STATIONARY DIESEL - ELECTRIC CUTTER SUCTION DREDGER. Built Holland 1953/4. Hull 115-ft. x 26-ft. 3-in. x 10-ft. 2 Sandpumps driven by 2 DEUTZ-Diesel engines, each 500 h.p. 380 r.p.m. Suction delivery 20-in. $\phi$ 2 continuous current electric sets, each driven by DEUTZ-Diesel engine, 150 h.p. 600 r.p.m. Cutter electric motor 100 h.p. Crown Cutter, Spuds, electric winches. Floating and static pipeline for shore-delivery.

**HENDRIK BOOGAARD - SLIEDRECHT**
**Holland - Postbox 40**
Cables: DRAGOB. Tel. 45 and 769.

*Sworn Brokers for Dredging and all further floating equipment.*